THE

PRACTICE OF NAVIGATION

AND

NAUTICAL ASTRONOMY.

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THE

PRACTICE OF NAVIGATION

AND

NAUTICAL ASTRONOMY.

BY

HENRY RAPER, Lieut. R.N., F.R.A.S., F.R.G.S

NINETEENTH EDITION.

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TO

REAR-ADMIRAL SIR FRANCIS BEAUFORT,

K C.B.

HYDROGRAPHER TO THE ADMIRALTY

SIR,

The eminent station which you occupy in the naval scientific world renders it highly gratifying to me to dedicate the following Work to you as a testimony of my regard and esteem; while the general accordance of my views on the subject with those of your more experienced judgment, gives me the greater confidence in laying my labours before the Public.

I have the honour to be,

Sir,

Your obedient Servant,

HENRY RAPER.

PREFACE

TO THE

FIRST EDITION.

This Work is intended for the use of all persons concerned either with the navigation of ships or with the determination of latitude and longitude on shore.

The present volume, which is devoted exclusively to the PRACTICE, contains all the rules and tables necessary in navigation, and for the determination of latitude and longitude by means of the sextant or reflecting circle. The study of its contents demands no previous attainments beyond the knowledge of the elements of arithmetic. Every endeavour has been made to render the whole easy of reference, and to adapt it to the use of those who may desire to instruct themselves. Rules which admit of more cases than one, as, for example, that for applying the equation of equal altitudes, are given in the form of *tables;* so that the several conditions involved, and their mutual connexion, being exhibited to the eye, the computer is relieved from the sense of complication, and the chance of a mistake is materially diminished. An ample alphabetical index is annexed, by which the reader is at once referred to all the information which the volume can afford him.

Those who have been brought up to the sea, and who have experienced the distaste for long calculations which that kind of life inspires, will not hesitate to admit that the only means of inducing seamen generally to profit by the numerous occasions which offer themselves for finding the place of the ship is extreme brevity of solution. It is not, however, merely as a concession to indolence, that rules should be made as easy and simple as possible; the nature of a sea life demands that every exertion should be made to abridge computation, which has often to be conducted in circumstances of danger, anxiety, or fatigue, and so to separate the several points, that the seaman may be referred directly to what concerns his case, to the exclusion of all other matter. These considerations have been carefully kept in view in the rules, in the examples, and in the form and order of the tables.

Two kinds of solutions are employed, and, in general, two only; namely, an *approximate* method, and a complete, or, as it is called, *rigorous*, method. The former may often serve in cases of haste, or when precision is not necessary, and will also afford a convenient check against the effects of a mistake in the more elaborate method.

All the computations are effected by the well-known methods of inspection and logarithms; and as the former, it is presumed, leave but little to be desired in point of expedition, Gunter's scale, or other mechanical methods, are not employed.

Sailing on a Great Circle is, in this work, reduced, like Plane Sailing, to Inspection, by means of the SPHERICAL TRAVERSE TABLE.

Convenient rules are given for finding the distance of the land by its change of bearing, and by its altitude observed above the sea-horizon.

The seaman will find every necessary information on the subject of local magnetic deviation.

The highly useful problem of determining the latitude at sea, by the reduction of an altitude to the meridian, will be found greatly abridged; and a table is added for the purpose of shewing the limits within which the result may be depended upon when the time at ship is in error. This table will be found, it is presumed, of considerable utility, as it is perhaps from the want of some specific information as to the degree of confidence which it is safe to place in the result, no less than of a short and easy rule, that this excellent observation is almost entirely neglected; and, in consequence, the latitude, when the meridian altitude is not exactly obtained, is too often lost for the day.

The approximate solution of the double altitude, as a question of Time, will be found, it is hoped, well adapted to general use: since unless the latitude by account is very much in error this method determines both the true latitude and the time at ship; and the computation of the time is one with which seamen are familiar in the next degree to that of the latitude by meridian altitude. The principle is not *new*, but rules have not hitherto been given for computing directly the error of the latitude by account.

The first approximate method of clearing the lunar distance is new, being effected, like many other problems, by the Spherical Traverse Table. The rigorous method is a modification of Borda's, and employs five logarithms, of which two only are taken out to seconds.

In a work in which many of the methods are new, I have felt it would be more satisfactory to the professional reader to find them illustrated by observations actually taken at sea. The examples are accordingly selected from the journals of Captain W. F. W. Owen, who kindly lent them to me for the purpose; though, necessarily, in proceeding by fixed rules, I could not introduce the solutions employed by that distinguished navigator. The remaining observations have been furnished to me by the Rev. G. Fisher, astronomer to Sir Edward Parry's expedition to the Polar Seas.

In order to enable the computer to judge of the degree of precision to which he attains, the *degree of dependance* to be placed on the result, or the limit of probable error, is indicated. This is the more important, as very indistinct and erroneous notions prevail among practical persons on the subject of accuracy of computation; and much time is, in consequence, often lost in computing to a degree of precision wholly inconsistent with that of the elements themselves. The mere habit of working invariably to a useless precision, while it can never advance the computer's knowledge of the subject, has the unfavourable tendency of deceiving those who are not aware of the true nature of such questions into the persuasion that a result is always as correct as the computer chooses to make it; and thus leads them to place the same confidence in all observations, provided only they are *worked* to the same degree of accuracy. By habitually following the short precepts laid down on this point, the computer will learn insensibly to estimate the value of his results; of which, since the limit of error is the sole criterion of the accuracy of any determination, he cannot otherwise be a judge. The degree of precision to which it is proper to carry the work in any case is observed, in general, in the examples.

In the Tables every endeavour has been made to render the collection complete for the purposes required, and to compress the whole into small compass. For the sake of clearness, a different figure has been adopted for the argument and for the numbers in the body of each table. In the logarithms six places of figures only are employed, because a single result in which six places are necessary cannot be depended upon to the degree of precision obtained. On the same principle, some of the logarithms are given to three places only.

The log. sine square of half the arc, Table 61, universally familiar to seamen in finding the time, is given, for the convenience of this constant computation, to every second of the 12 hours. By means of this term tables of versed sines are dispensed with, all our solutions being either numeral or purely logarithmic.

I have not, either in the Rules or the Tables, aimed to make that additive which is in the nature of things subtractive. The precept *subtract* is as easy as the precept *add;* and when the student has the natural process before him he may be led to discover the reason of it; and must thus, by attention, always advance in knowledge of the subject. But an artificial process obstructs the exercise of the faculties, or leads the student, who reflects on what he does, to false conclusions.

The composition of the Table of MARITIME POSITIONS has been a very laborious task, and has caused great delay in the appearance of the Work. The numerous chronometric measures furnished of late years have rendered it necessary to deduce longitudes in a more systematic and accurate manner than that hitherto followed, which has chiefly consisted in modifying former determinations by means of those succeeding them. *Absolute*, or astronomical positions, and *relative* positions, being distinct things, and the latter being by far of the greater consequence to navigation, it is necessary, preparatory to a complete and final arrangement, to separate these two kinds of determinations. Accordingly, in a series of papers, some of which have been already published in the Nautical Magazine,* I have endeavoured to arrange the chronometric differences of longitude with reference to certain fixed points, convenient for the purpose, which it is proposed to call *Secondary Meridians*. These standard

* The *data* or evidence for the several positions being given in these papers, the value of each determination is easily appreciated ; and accordingly, individuals in possession of one or more good watches may, by correcting defective measures, or by establishing new links of connexion, render material service to maritime geography. See Nautical Magazine, 1839, and following years.

positions, of which the number assumed is eighteen, being considerably distant from each other, are determined nearly enough for present purposes, and would, according to the system proposed, be finally settled by long series of astronomical observations.

An account of the principles adopted in this arrangement, and of the several voyages and surveys from which the materials have been taken, will be found, together with some suggestions for the advancement of the subject, in the *Nautical Magazine.* But it is necessary to state here, that the late determinations of the longitude of Madras have, from the importance of that position, occasioned a long and intricate discussion. Mr. Riddle and Mr. Maclear have compared observations of moon culminating stars made at Madras, with like observations made in Great Britain and at the Cape of Good Hope respectively. According to their computations, which agree very nearly, the received longitude, 80° 17′ 21″, is about 3′ 21″ too great. The number and superior character of these observations, and the agreement of the results, have led me to adopt, without hesitation, 80° 14′ 0″; while the magnitude of the correction has rendered it indispensable to trace its effects on the longitudes of the Eastern Seas.*

Precision in the Maritime Positions, especially in the longitudes, becomes, as navigation advances to perfection, a matter of increasing importance; because, where longitudes are well determined, the error of a chronometer may be ascertained on every occasion of making the land.

It will not be out of place to remark here that it is high time the chronometer should be found, like the compass, among the stores of every vessel beyond a mere coaster. It would be superfluous to attempt to prove that the hardships and privations consequent on missing a port, the losses of ships from being out in their reckonings, and the evils incident to navigation generally from the want of a ready means of checking the enormous errors to which the dead reckoning is liable, would, in many cases, have been prevented by a chronometer.

In urging this recommendation, it is, of course, taken for granted that they to whose hands the chronometer is entrusted are qualified to make a proper use of it. Employed merely as a check, a single chronometer cannot fail to prove of great service; but too firm a reliance on such an instrument would lead to the dangerous error

* The accepted Longitude of Madras, India Trigonometrical Survey, 1878 (see page 394), is 80° 14′ 51″ E

of relaxing that vigilance which the known uncertainty of the dead reckoning keeps perpetually alive.

A list of times of high water, or, as they are now called, Establishments of Ports, is not given. The researches on the tides made of late years by Mr. Lubbock and the Rev. W. Whewell, have proved that the establishment cannot be truly deduced but from numerous observations, and consequently that a simple recorded time of high water is altogether insufficient. Moreover, if the establishment were correctly known, the time of high water, as also the height of the tide, cannot be determined without other elements, which, except in comparatively few places, are not afforded. But in navigation it is not the true instant of high or low water that is required so much as the time at which the flood or ebb stream turns, because this last affects every vessel when near the shore; and the proper place for information of this kind is, obviously, the Sailing Directions.

Although some results of the kind might be advantageously placed in a general work on navigation, yet the uncertainty of almost all that has been published, and the difficulty of collecting better materials, will, it is hoped, excuse the omission, at least for the present.

It may, however, be remarked, that under whatever form it may hereafter be found advisable to publish particulars of the tides, the observations required are so numerous, the discussions so tedious, and the whole subject so complicated, that no individual could undertake successfully to treat this branch of navigation unless in a work devoted exclusively to its consideration.

The subject of Maritime Surveying, usually treated in works of this kind, has been omitted. Surveying is no part of the navigation of a ship, and a survey having any pretensions to authority can scarcely be made by a person whose qualifications for the task are confined to the slender information contained in a few pages. A survey is a matter of too great consequence to the security of navigation to be received from incompetent hands; and the seaman who desires to acquire a knowledge of surveying should study works treating expressly of this branch of science.

The customary chapter on the Winds has likewise been omitted. The subject, generally, does not belong to the navigation of a ship; and, even if it did, the general information contained in a few pages, though interesting as a branch of natural philosophy, is necessarily too vague to be effective in shaping the course. The same applies to Currents, and also to the Marine Barometer; which, though matters of important consideration in sea-voyages, are not concerned in the practice of navigation, since this term, in strictness, comprehends only the consideration of the place of the ship when her circumstances and destination are given.

The space gained by the omission of these collateral subjects, and other matters sometimes introduced, is appropriated to the numerous practical details of the proper subjects of such a treatise.

The Work will be completed by another volume, which will be entitled the Theory of Navigation, and will contain the construction of the rules and tables, for the advantage of those who desire to confirm their practical knowledge by mathematical investigation. It will contain, likewise, those methods in which the transit and azimuth instruments are employed. The present volume being thus, in the ordinary practice of navigation, independent of the second, no notice of another volume appears in the title-page.

By the term Theory is commonly understood, in this particular subject at least, the scientific principles on which the rules are formed. Considerations of this kind are thus altogether excluded from the present volume; but, on the other hand, that *rationale*, or process of reasoning, which, in considering the nature of the case, is obvious to common sense or apprehension, is, in most cases, introduced, as necessary to a clear understanding of important points.

The theory and the practice are thus kept purposely distinct. The former is not always necessary to successful practice; and rules constructed for ready and general application approach to perfection in proportion as they leave less to individual judgment or skill. It is the custom, generally, to teach the theory first; the impression forced upon me is, on the contrary, that the practice is itself the best foundation for sound and rapid advancement in the theory. For he who has acquired the practice knows the nature and extent of the subject; and in proceeding to the theory he has a distinct perception of the object to be attained. This is not the place for a discussion on these points; but it was incumbent on me to state, in a few words, the grounds of the arrangement adopted.

It is manifestly the duty of a writer, who undertakes to treat a subject in a thoroughly practical manner, not only to discuss every point which presents itself, but also to pronounce a decided opinion in every case. It is proper to bring this point under the notice of the reader, who, especially if he has more experience in these matters than myself, might otherwise be disposed to consider many things in this volume as laid down too positively.

I cannot close the preface to a work which has been some years in preparation, and in which I have endeavoured to reduce to a practical form every useful consideration which has been suggested by my own experience or by intercourse with eminent officers and men of science, without soliciting the indulgence of the reader to errors and to deficiencies. Absolute correctness, especially in tables, is scarcely attainable; and in a treatise which contains much that has not appeared before, I cannot reasonably flatter myself that, notwithstanding every care and attention, some small inaccuracies may not be found.

H. B

September 1840

ADVERTISEMENT

TO THE

THIRD EDITION.

In the Advertisement to the Second Edition I had the satisfaction of being able to state that the Royal Geographical Society had conferred the flattering distinction of their gold medal on the first edition, and that the Lords Commissioners of the Admiralty had honoured my work by ordering it to be supplied to Her Majesty's Navy as ship's stores.

The present edition has been greatly augmented. Much of the work has been rewritten. Two approximate methods of determining the time, though of inferior value, are introduced, since a work aiming to be complete for practice should contain provision for extreme cases. Nos. 789, 791.

The introductory portion, it had often been suggested, was insufficient for the purposes of elementary instruction. It is easier to allege this, than to lay down a condition which is to determine the extent of such preliminary matter. An attempt, however, has been made to fix a limit, on the following grounds:—

The most general defect, perhaps, in the education of seamen, as regards the present subject, is an insufficient knowledge of arithmetic; by which I mean, not of the more advanced rules, but of the elements, and especially of proportion. Now all questions to which arithmetical processes are applied involve some *proportion*, which the operation is to bring out, or distinctly assign; and it appears, accordingly, a great omission in our education that we are not more exercised on this point, which is the sole object or end of the processes which we learn to practise mechanically.

Again, in geometry, it is not the variety of problems which benefits the practical man, but a well-grounded and familiar knowledge of a few comprehensive propositions, which he applies readily, and with confidence; and the geometrical knowledge which appears to me to suffice to our present purpose is comprised in,—1, the property of the square of the hypothenuse; 2, the measure of an angle at the circumference; 3, the similarity of plane triangles The first is of general importance; the second includes the problem of fixing a station by means of two angles subtended by three objects; and the third is the basis of trigonometry.

In this edition, therefore, proportions and fractions are treated at some length, and illustrated by numerous examples which afford the student abundant exercise; and a short course of geometry is given, after the manner of Euclid, sufficient to establish the above important theorems.

These limitations, the reader will bear in mind, are intended to apply only to that particular quantity of elementary matter which is assumed to be necessary and sufficient for the scale of attainment contemplated in the present volume.

In the Table of Positions many points of information of consequence to seamen are expressed by means of a new system of Symbols. In these days little apology is required for introducing a scheme which a few years ago would have been deemed a rash innovation. But a growing tendency to the use of symbols manifests itself on all sides. Efforts have been made to represent, as far as possible, all matters of instruction under a form addressed to the eye;* and symbols effect this object in an eminent degree, for their distinct and conspicuous forms, contrasting with the monotonous aspect of alphabetic writing, arrest and fix the attention, while their extreme conciseness admits the insertion of matters to which, for want of room, no allusion could otherwise be made.

The employment of symbols, therefore, on a more extensive scale than we have yet been used to, and that at no distant period, may be considered inevitable; and the present system, which has occupied my attention for several years, is proposed as so far deserving consideration that it is constructed with rigid adherence to principles.† The number of signs which I have ventured to

* The Physical Atlas is an example.

† The necessity for a uniformity in hydrographic symbols has already shewn itself. Symbols similar in character denote, on the French charts, rocks *above* the water, and on the Russian charts rocks *below* the water.

introduce is small, since, in matters waiting the sanction of experience, it is better to move too slow than too fast.

The introduction of symbols has necessarily modified the original design of the work, as described in the preface, and has justified allusion to many matters which otherwise would not have found a place in it.

The chief labour of this edition (as, indeed, of the two former) has been the Table of Positions, which, in consequence of the numerous references made to my labours in this country and abroad, I was desirous to extend. The list now contains 8,800 places; and as the degree of accuracy is indicated wherever I have found the means of forming a judgment, and as many physical details are supplied,—such as the dimensions of islands, heights, and the depths of shoals,— the table may be considered as representing the state of maritime geography at this day. The number of voyages, charts, and surveys, which it has been necessary to consult, — the labour of digesting and comparing the mass of materials collected, and the introduction, by a new method, of numerous details important to navigation,—will, it is hoped, excuse the long delay in the appearance of this edition, and account for the work having remained out of print for nearly three years.

In conclusion, I gladly express my obligation to the draftsmen and other gentlemen of the Hydrographic Office, whose patience during many years I have sorely taxed in the inspection and re-examination of thousands of documents, and without whose active and disinterested assistance I must have left much in a very unsatisfactory state.

ADVERTISEMENT

TO

THE NINETEENTH EDITION

The revision and enlargement of this edition of the "Practice of Navigation and Nautical Astronomy" was undertaken with considerable diffidence, it being felt, that while it was possible to spoil, little could be done to improve, this best of practical works on Navigation at Sea.

Compiled in the golden age of practical Navigation and Nautical Surveying by an officer in constant communication with Beaufort and Horsburgh, and the Captains and Masters who served under these distinguished chiefs in England and India, Lieutenant Raper's labours are founded upon a thorough practical experience, and may be looked upon as the work of a Sailor for the use and benefit of Sailors at Sea.

One chapter alone required to be re-written. The use of iron in modern shipbuilding, by its natural effect on the Mariner's Compass, having greatly increased the difficulties of navigation at sea, some additions have therefore been made to what Raper had already written upon this important subject. This chapter, as well as all parts of the book referring to the variation and deviation of the compass, has been re-written by Captain W. Mayes, R.N., late Superintendent of Compasses at the Admiralty.

Captain Mayes has also assisted in making a careful examination of the whole work, which is sufficient guarantee for its having been thoroughly done.

This scrutiny showed how well and earnestly Raper had carried out the intention expressed in the Preface to his First Edition * (see p. v) of "inducing seamen to profit by the numerous occasions

* Sailors are earnestly requested to read the Preface to the First Edition

which offer themselves for finding the place of the ship;" by laying before them methods whose "extreme brevity of solution abridged computation." These short rules aid the prompt decision upon which the safety and success of a ship at sea so often depend. A brief study of the comprehensive index will call attention to "the numerous occasions" alluded to.

The key to most of the modern short methods for fixing the position of the ship will be found in Raper's "Practice of Navigation."

Under the head of "Degree of Dependance" is placed before the navigator the amount of possible error, a thought which should never be absent from his mind in considering the estimated position of a ship, with the view of determining his future proceedings.

The sailor's attention is earnestly called to the chapter entitled "Navigating the Ship," which contains what John Davis, the navigator, writing in 1607, aptly termed the "Seaman's Secrets."

In this, the concluding chapter of the work, Raper shows clearly the never ceasing watchfulness that is required, in both fair and foul weather, in obtaining the observations, terrestrial as well as celestial, necessary to conduct a vessel in safety from one port to another.

The simplicity of its mathematical theory makes Navigation appear an easy matter to men teaching or using it on shore; but Pilotage, common and proper, is a very different business when practised by sailors in a gale of wind, at night, or in hazy weather, on board a ship at sea. Proficiency in the science can never compensate for a lack of experience in the handicraft of navigation. This experience can be attained only by incessant practice at sea; by a capacity for taking trouble, unceasing caution, and a desire to do well.

In such labours the sailor will find no better friend and assistant than Raper's "Practice of Navigation."

No changes in the numbering of the paragraphs have been made, and great care has been taken to leave the book in the style in which it was originally written, so that old students will have no difficulty in finding the various methods with which they are familiar.

Some slight changes have been made in the Tables. Considering the great increase of speed attained by modern steamships, Table 1, formerly Table 2, has been enlarged from 300 to 600 miles of distance. The Table giving the Diff. lat. and Departure for every quarter point has been withdrawn.

Table 10, of Maritime Positions, upon which Raper bestowed a very large amount of labour, has been revised with great care from the latest Admiralty Charts, so that it may still "be considered as representing the maritime geography of this day" (see p. xv). These positions mainly depend on the Table of Longitudes accepted for Secondary Meridians, amended from telegraphic observations to 1887, published in the Admiralty "Instructions to Hydrographic Surveyors." This Table of Secondary Meridians has been inserted in the Explanation of Table 10.

Steam having in a great measure rendered Table 12 obsolete, it has been replaced by a Table of the navigable Mercatorial Distances between the principal ports and points of the world.

Tables 11 and 13 (Approximate Variation of the Compass, and Tide-hours, or Establishment of the Ports) have been taken out, as the Admiralty Charts, and Admiralty and Indian Tide Tables, published yearly; with the Chart of Curves of Equal Magnetic Variation (No. 2598), corrected up to date; always give the latest information. These tables have been replaced by others showing first: where docks &c. may be found and coals obtained; and second, the position and nature of the Time signals, in all parts of the world, for the correction and rating of chronometers.

Table 65, of natural sines, tangents, &c., to assist magnetic computations, has been inserted in lieu of that of log. sines, tangents, &c., to quarter points.

With these few exceptions the Tables retain the same numbers they held in former editions.

In conclusion, thanks are due to Captain John C. Almond, Nautical Inspector of the P. and O. Company, for his many valuable suggestions.

THOMAS A. HULL.

Mamre, Honor Oak:
December 21, 1890.

In this reprint of the Nineteenth Edition, the Sun's declination, the Sidereal Time, and the Equation of Time have been given for the years 1901, 1902, 1903 and 1904, in Tables 60, 61, and 62. Table 60A, correction of Sun's declination in Table 60 to 1928, has been restored. Tables 10, 12, and 13 have been brought up to date. Table 38, Corrections of Altitudes of Sun and Stars, has been extended, and the gross corrections are given for 'Height of the eye' up to 60 feet. Table 47, Limits of the Reduction to the Meridian at Sea, has been recast. Table 70, Logarithms for computing the Reduction to the Meridian at Sea, has been extended to 35° of declination. Tables 41 and 52 have also been recast.

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NAVIGATION.

NAUTICAL ASTRONOMY.

INTRODUCTION.

I. Fractions. II. Proportion. III. Logarithms. IV. Practical Geometry. V. Raising the Trigonometrical Canon. VI. Methods of Solution.

1. *Vulgar Fractions.*

1. A number which is a portion of 1, or unity, is properly called a *fraction*; thus, if we divide a foot into 3 equal parts, each of such parts is the fraction called a *third*, and written $\frac{1}{3}$.

These numbers arise, in arithmetical operations, in division, when the dividend is not divisible by the divisor in whole numbers, or, as they are called, *integers*; thus, if we divide 10 feet into 3 equal parts, each will measure 3 ft. and one-third, or 10 divided by 3 gives the quotient 3, and 1 over—that is, 1 not divided like the rest; but proceeding now to divide this 1 by 3, we call the result or quotient $\frac{1}{3}$; that is, 1 *divided by* 3.

2. If we divide 1 into four equal parts, each is one-*fourth*, written $\frac{1}{4}$; if into 5 equal parts, each is one-*fifth*, written $\frac{1}{5}$; thus, the *name of the fraction* is that of the *number of parts* into which the unity or entire quantity is divided; and this number is hence called the *denominator* of the fraction.

3. If we take two of three equal parts of subdivision, or two-thirds, we write $\frac{2}{3}$; if we take three of four equal subdivisions, we write $\frac{3}{4}$; if we take three of seven equal subdivisions, we write $\frac{3}{7}$; and so on: the number 2, 3, in these examples, which shews or enumerates the number of fractional parts taken, is hence called the *numerator*.

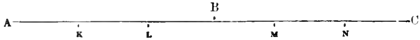
The term fraction is thus used to denote not only one part or subdivision, but any number of such.

4. In enumerating fractional parts we may go on, for example, $\frac{1}{5}$, $\frac{2}{5}$, $\frac{3}{5}$, $\frac{4}{5}$, $\frac{5}{5}$, $\frac{6}{5}$, $\frac{7}{5}$, &c. Here $\frac{5}{5}$ represents the whole, or entire quantity, since it enumerates as many parts as the whole is divided into; the fractions (so called) beyond this, as $\frac{6}{5}$, $\frac{7}{5}$, are all greater than 1, and are termed mixed or *improper* fractions.

5. The fractions to the left of $\frac{5}{5}$ are less than 1, and are *proper fractions*; hence, when the numerator is less than the denominator, the fraction is less than 1; when equal, the fraction represents 1; and when greater, it is greater than 1, and is capable of being resolved into a whole number with or without a fraction.

Hence also, the greater the denominator the smaller the fraction, and the smaller the denominator the larger the fraction.

6. If we take a line AB, and divide it into 3 equal parts by the points K, L; and another line BC equal to it, and divided similarly at M, N, then AL is $\frac{2}{3}$ of AB, or of 1.



Then the parts being all equal, AK and KL, are equal to LB and BM, and these to MN and NC; therefore AK and KL are $\frac{1}{3}$ of AC, that is, of 2. Hence AL is $\frac{2}{3}$ of 1, and $\frac{1}{3}$ of 2; or, $\frac{1}{3}$ of 2, and $\frac{2}{3}$ of 1 are the same thing. If AB is 1 yard, it is evident at once, since 2 ft. or $\frac{2}{3}$ of 1 yard are $\frac{1}{3}$ of 6 feet, or 2 yards.

7. The value of a fraction is not changed by multiplying the numerator and denominator by the same number.

The term one-half is equivalent to two-quarters, to four-eighths, and so on; that is $\frac{1}{2}$, $\frac{2}{4}$, $\frac{4}{8}$, &c. are all equal; since it is evident that the result is the same if we divide the whole into twice the number of parts, and take twice the number, or into 3 times the number of parts, and take 3 times as many of them. The above fractions are $\frac{1}{2}$, the numerator and denominator being both multiplied successively by 2.

Again, take $\frac{2}{5}$, multiply both numerator and denominator by 3, it becomes $\frac{6}{15}$: if now we take a line and divide it into 5 equal parts, and 15 equal parts, it will be the same thing whether we take two of the larger parts, or six of the smaller, which are $\frac{1}{3}$ the size.

8. The value of a fraction is not changed by dividing the numerator and denominator by the same number. This appears in exactly the same way as the above, in any case; thus, $\frac{6}{15}$, dividing both numerator and denominator by 3, gives $\frac{2}{5}$. The process is equivalent to dividing the unit into larger portions, and taking fewer of them in proportion

Fractions are thus often simplified: example, $\frac{22}{224}$ is evidently reducible to $\frac{11}{112}$; $\frac{35}{110}$ to $\frac{7}{22}$.*

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* A fraction is reduced to its simplest terms by finding their *greatest common measure*, that is, the largest number which will divide them both without a remainder. To find the greatest common measure of two numbers,

Divide the greater by the less. Consider the remainder as a new divisor to the former divisor as a dividend, and find the next remainder. Consider the last remainder as a new divisor, and find the next remainder, and so on. The last divisor is the number required.

If the last divisor is 1, the numbers have no common measure but 1, that is, are not further reducible.

Ex. 1. Find the greatest common measure of 24 and 124.

24)124(5
120
4)24(6
24
Ans. 4. 0

Ex. 2. Find the greatest common measure of 48 and 11.

11)48(4
44
4)11(2
3
3)4(1
3
Ans. 1

[1.] *Reduction to a Common Denominator.*

9. Suppose it is required to add together $\frac{2}{3}$ and $\frac{3}{5}$; if we could at once express thirds in fifths, or fifths in thirds, we should then merely enumerate the number of parts; but as one of these fractions is no exact number of times greater than the other, (as may be seen by dividing a line into 5 parts and 3 parts), we cannot do this. But by multiplying the numerator and denominator of one by some number, and of the other by some other number, (which leaves the fractions unchanged in value, No. 6) we may select such multipliers as will produce the same number in the denominator; thus, multiplying the numerator and denominator of $\frac{2}{3}$ by 5, gives $\frac{10}{15}$, and multiplying the numerator and denominator of $\frac{3}{5}$ by 3 gives $\frac{9}{15}$, and the fractions $\frac{2}{3}$ and $\frac{3}{5}$ are thus reduced to 15ths.

Again, to reduce $\frac{3}{12}$ and $\frac{7}{11}$ to the same denominator, multiply the numerator and denominator of $\frac{3}{12}$ by 11, which gives $\frac{33}{132}$, and $\frac{7}{11}$ by 12, which gives $\frac{84}{132}$. These reductions are effected by multiplying each numerator by the *other* denominator, and the two denominators together; and the same applies to three or more fractions taken in succession. Hence the

Rule: Multiply the numerator of each fraction by every denominator, except its own, for the new numerator, and multiply all the denominators together for the new denominator.

Ex. 1. Reduce $\frac{2}{3}$, $\frac{1}{15}$, and $\frac{1}{7}$. $\frac{2\times 15\times 7}{3\times 15\times 7}$, $\frac{1\times 3\times 7}{3\times 15\times 7}$, $\frac{1\times 3\times 15}{3\times 15\times 7}$, or $\frac{210}{315}$, $\frac{21}{315}$, $\frac{45}{315}$.

Ex. 2. Reduce $\frac{11}{17}$, $\frac{1}{2}$, and $\frac{4}{7}$. $\frac{11\times 2\times 7}{17\times 2\times 7}$, $\frac{1\times 17\times 7}{17\times 2\times 7}$, $\frac{4\times 17\times 2}{17\times 2\times 7}$, or $\frac{154}{238}$, $\frac{119}{238}$, $\frac{136}{238}$.

Ex. 3. Reduce $\frac{2}{5}$, $\frac{5}{12}$, and $\frac{6}{7}$. $\frac{168}{420}$, $\frac{175}{420}$, $\frac{360}{420}$.

10. The process of reduction to a common denominator is often necessary in the comparison of two fractions, to find which of the two is the greater; thus, to compare $\frac{3}{16}$ and $\frac{7}{34}$, these become $\frac{102}{544}$ and $\frac{112}{544}$ hence $\frac{7}{34}$ is the greater.

11. Whole numbers are written in the fractional form by employing 1 as the denominator; thus 3 is written $\frac{3}{1}$, the 1 is in the place of the unit divided into 1 part (No. 2), that is, left entire, and the 3 denotes that 3 such parts are taken (No. 3).

12. By means of this last notation whole numbers are reduced to fractions with the same denominator, by the rule No. 9. Thus 11 and $\frac{3}{4}$, or $\frac{11}{1}$ and $\frac{3}{4}$ become $\frac{44}{4}$ and $\frac{3}{4}$.

[2.] *Addition.*

13. Reduce the fractions to a common denominator, add the numerators (No. 9), and under the sum place the common denominator.

Ex. 1. Add together $\frac{3}{17}$ and $\frac{2}{3}$. These become $\frac{3\times 3}{17\times 3} = \frac{9}{51}$, and $\frac{2\times 17}{3\times 17} = \frac{34}{51}$; the sum of which is $\frac{43}{51}$.

Ex. 2. Add together $\frac{1}{2}$, $\frac{1}{4}$, and $\frac{1}{8}$. Ans. $\frac{7}{8}$.

Ex. 3. Add $\frac{8}{10}$, $\frac{2}{7}$, and $\frac{3}{100}$. Ans. $\frac{7810}{7000} = 1\frac{81}{700}$.

Ex. 4. Add $\frac{3}{10}$, $\frac{2}{16}$, and $\frac{1}{3}$. Ans. $\frac{364}{480} = \frac{91}{120}$.

[3.] *Subtraction.*

14. Rule: Reduce the fractions to a common denominator, and subtract the lesser numerator from the greater for a numerator. Thus, suppose it required to subtract $\frac{1}{6}$ from $\frac{1}{5}$, these become $\frac{5}{30}$ and $\frac{6}{30}$, and $\frac{5}{30}$ from $\frac{6}{30}$ leaves $\frac{1}{30}$, the remainder required.

Hence it appears that the difference between $\frac{1}{5}$ part and $\frac{1}{6}$ part is $\frac{1}{30}$ of the whole.

Ex. 1 Find the difference between $\frac{3}{7}$ and $\frac{2}{5}$. These become $\frac{15}{35}$ and $\frac{14}{35}$, the difference of which is $\frac{1}{35}$.

Ex. 2. Subtract $\frac{1}{33}$ from $\frac{2}{11}$. Ans. $\frac{55}{363}$.

Ex. 3. Subtract $\frac{12}{13}$ from $\frac{11}{5}$. Ans. $\frac{83}{65} = 1\frac{18}{65}$.

[4.] *Multiplication.*

15. To multiply a fraction by a whole number is to repeat the fraction a given number of times; that is, to multiply $\frac{1}{4}$ by 3, or to take $\frac{1}{4}$ three times, gives $\frac{3}{4}$. Hence to multiply a fraction by a whole number is to multiply the numerator.

Hence a number multiplied by a (proper) fraction is diminished; thus, 3 multiplied by $\frac{1}{4}$, which is $\frac{3}{4}$, is less than 3.

16. To multiply a fraction by a fraction, as for example $\frac{3}{7}$ by $\frac{2}{5}$. Since $\frac{2}{5}$ is the same as twice one-fifth, we have to take $\frac{1}{5}$ of $\frac{3}{7}$, and double the result.

To take $\frac{1}{5}$ of $\frac{3}{7}$ is to divide $\frac{3}{7}$ into 5 parts and take one of them; now $\frac{3}{7}$ is $3 \times \frac{1}{7}$ (by No. 6), and dividing $\frac{1}{7}$ into 5 equal parts gives $\frac{1}{35}$, since 5 such parts repeated 7 times make up 1. Hence 3 of these parts (or $\frac{3}{7}$ divided into 5 parts) is $\frac{3}{35}$, which is therefore $\frac{1}{5}$ of $\frac{3}{7}$. and $\frac{3}{35}$ doubled, or $\frac{6}{35}$, is $\frac{2}{5}$ of $\frac{3}{7}$.

Now, the numerator 6 is the product of the two given numerators, 2 and 3 (as appears by the process); and the denominator 35 is the product of the denominators 7 and 5. If we had to multiply this result by a third fraction, the process would be the same; hence the

Rule. Multiply all the numerators together for a new numerator, and all the denominators for a new denominator.

Ex. 1. Multiply $\frac{1}{3}$, $\frac{2}{5}$, and $\frac{6}{7}$. Ans. $\frac{12}{105}$. Ex. 2. Multiply $\frac{32}{63}$, by $\frac{2}{7}$. Ans. $\frac{64}{441}$

Ex. 3. Multiply $\frac{11}{16}$, $\frac{7}{3}$, and $\frac{1}{5}$. Ans. $\frac{77}{240}$.

17. If we multiply $\frac{2}{3}$ by itself, we have $\frac{4}{9}$, this again by $\frac{2}{3}$ gives $\frac{8}{27}$; now $\frac{8}{27}$ differs little from $\frac{8}{28}$, and $\frac{8}{28}$ is equal to $\frac{2}{7}$, which is very

much less than $\frac{1}{3}$. Again, $\frac{1}{4}$ multiplied by itself is $\frac{1}{16}$, and this multiplied again by $\frac{1}{4}$ is $\frac{1}{64}$.

Hence a proper fraction is diminished by continually multiplying it by itself.

[5.] *Division.*

18. To divide a fraction, as $\frac{1}{3}$, by a whole number, as 4, is to find a new fraction which, repeated 4 times, shall produce $\frac{1}{3}$: that is, we have to divide a third into 4 equal parts.

It will be at once seen, on dividing a line into 3 equal parts, that to divide each third into 4 equal parts, is to divide the whole line into 12 equal parts, and since 4 of such parts, or twelfths, constitute a third, $\frac{1}{12}$ is the required fraction. Hence, as similar reasoning applies to any other fraction or whole number, the most general rule for dividing a fraction by a whole number is to multiply the denominator by the given whole number; but if the numerator be a multiple of the divisor, it is better to divide the numerator as it leaves the result in a more reduced state.

19. To divide a whole number, as 3, by a fraction, as $\frac{1}{4}$. Dividing 3 by 1, that is, finding how often 1 is contained in 3, gives 3. Now, it is easily seen, since $\frac{1}{4}$ is 4 times *smaller* than 1, that it must be contained in 3, four times *oftener*, that is 12 times; and 12 is the product of 3 by the denominator 4.

To divide 3 by $\frac{2}{5}$. Since $\frac{2}{5}$ is twice $\frac{1}{5}$, we have to divide 3 by $\frac{1}{5}$, and take half the quotient; and we know that to divide by the product of two numbers, $2 \times \frac{1}{5}$, is the same thing as to divide by them separately, that is, 3 divided by $\frac{1}{5}$ is 3 multiplied by 5 (No. 18), and divided by 2; or $3 \div \frac{2}{5}$ is the same as $3 \times \frac{5}{2}$, or $\frac{15}{2}$.

Here $\frac{5}{2}$ is the fraction $\frac{2}{5}$ inverted.

As similar reasoning applies to any numbers and fractions, we have the

Rule. To divide by a fraction, invert the fractional divisor, and proceed as in multiplication.

20. To divide a fraction by a fraction. We have evidently to treat the dividend as a whole number, and apply to the divisor the rule above.

Ex 1. Divide $\frac{7}{12}$ by $\frac{2}{3}$. $\frac{7}{12} \times \frac{3}{2} = \frac{21}{24} = \frac{7}{8}$. Ex. 2. Divide $\frac{3}{4}$ by $\frac{2}{5}$ Ans $\frac{15}{8}$.

Ex. 3. Divide $\frac{2}{7}$ by $\frac{9}{11}$. Ans. $\frac{22}{63}$.

Hence it appears that the smaller the fractional divisor the greater is the quotient.

21. When a quantity is both multiplied and divided by the same number, it remains unchanged. Hence when the same number occurs in the numerator and denominator of a fraction, or of two or more fractions multiplied together, we simply omit or erase it; as,

$$\frac{1 \times 2}{2} = 1, \quad \frac{1}{4} \times \frac{4}{3} = \frac{1}{3}, \quad \frac{4}{7} \times \frac{1}{6} \times \frac{7}{16} = \frac{4}{16} \times \frac{1}{6} = \frac{1}{4} \times \frac{1}{6} = \frac{1}{24}, \quad 6 \times \frac{1}{6} = 1.$$

II. *Decimal Fractions.*

22. Tenths, hundredths (which are tenths of tenths), and so on, are called *Decimal Fractions*, and may be written as fractions, having for denominators 10, 100, &c., thus, one-tenth, $\frac{1}{10}$; three hundredths, $\frac{3}{100}$, &c. But as these quantities are counted by *tens*, like common numbers, it is simpler and more concise to write them *in continuation* with the common numbers, only taking care to put a dot, called the *decimal point*, where the whole number ends and the fraction begins; that is, between the unit and the tenth: thus, 21·32 signifies 21 and 3-tenths and 2-hundredths; 432·9 signifies 432 and 9-tenths; 33·05 signifies 33, no tenths, 5 hundredths.

23. In the fractional part beyond the dot, each figure may be read in its separate denomination, or the whole may be read in the denomination of the last: thus, ·32 is read either as 3-tenths and 2 hundredths, or as 32-hundredths; just as 32 is read either as 3 tens and 2 units, or as 32 units.

24. As ·5, (or 5-tenths) is the half of 1, so ·05 is the half of 0·1, or 5 hundredth-parts are the half of one-tenth; 5 thousandth-parts are the half of a hundredth-part. The half of 5 tenths is 2 tenths and half a tenth, that is, 2 tenths and 5 hundredths, or 0·25. Hence the fractions, *quarter*, *half*, and *three-quarters* are written in decimals, 0·25, 0·5, and 0·75.

All the preceding rules apply equally to decimal fractions, but as these last, from their denominators being multiplied by 10, are of a uniform kind, special rules have been made for them, relating, however, almost entirely to the placing of the decimal point.

[1.] *Addition and Subtraction.*

25. Place the quantities so that their decimal points shall be in the same vertical line; for then the quantities of the same denomination will stand together.

Then proceed as in the addition or subtraction of whole numbers.

Ex. 1. Add together 0·35, 47·4, and 9·12.

	0·35
	47·4
	9·12
Sum	56·87

Ex. 2. Add together 72·99, 4·1, and 52·31.

	72·99
	4·1
	52·31
Sum	129·40

Ex. 3. From 31·8 subtract 11·62.

	31·8
	11·62
Rem.	20·18

Ex. 4. From 423·5 subtract 97·9.

	423·5
	97·9
Rem.	325·6

[2.] *Multiplication.*

26. Multiply the numbers together as whole numbers, and point off as many decimal places in the product (beginning at the right) as there are decimal places in the multiplier and multiplicand together.

When the decimal places to be pointed off are more in number than the figures of the product, make up the proper number by prefixing ciphers to the product.

Ex. 1. Multiply 34·11 by 3·72.

```
     34·11
      3·72
     6822
    23877
   10233
Ans. 126·8892
```

In 34·11 are two decimals; in 3·72 are two; therefore four decimal places are pointed off.

Ex. 2. Multiply ·201 by ·06

```
      ·201
       ·06
Ans. ·01206
```

The product of 201 by 6 is 1206; in ·201 are three decimals, in ·06 are two; to make up five decimals, a cipher is prefixed to 1206.

Ex. 3. Multiply 90·01 by 0.034. Ans. 3·06034.

Ex. 4. Multiply together 1·3, 1·2, and 0·09. Ans. 0·1404.

[3.] *Division.*

27. Divide as in whole numbers. The rule for placing the decimal point is, that the quotient and divisor together must contain as many decimals as the dividend.*

Ex. 1. Divide 17·34 by 3·4.

```
3·4)17·34(51
    170
     34
     34
```

Here 17·34 contains two decimals, 3·4 contains only one; therefore 51 must contain the remaining one required, and be written 5·1.

Ex. 2. Divide 541·2 by 66.

```
66)541·2(82
   528
    132
    132
```

Here 541·2 contains one decimal, 66 none; hence 82 must contain one, and be written 8·2.

Ex. 3. Divide 2·392 by 4·6.

```
4·6)2·392(52
    230
     92
     92
```

Here 2·392 contains three decimals, and 4·6 one, the remaining two required must therefore be obtained by pointing off both figures of 52 thus, ·52.

Ex. 4. Divide 338·4 by 9·4.

```
9·4)338·4(36
    282
     564
     564
```

Here the dividend has one decimal, and the divisor also one, or as many, and the quotient is therefore an integer.

28. When the dividend has no decimals, ciphers must be annexed, preceded by the decimal point.

Ex. 1. Divide 19 by ·04.

Annexing two ciphers to 19, gives the complete quotient 475.

Ex. 2. Divide 132 by 0·7.

Annexing five ciphers (decimals) gives quotient 1885714. Then the number which added to one decimal in 0·7 to make up five, is four. Ans. 188·5714.

29. When the number of figures in the quotient is not sufficient to make up the required number of decimals, ciphers must be prefixed.

* It is always easy to verify the quotient, since multiplying it by the divisor should reproduce the dividend: thus, in Ex. 1, 5·1 × 3·4 gives (by No. 26) 17·34. The learner should also exercise his common sense on the results as a security against gross mistakes; thus, 17·34 divided by 3·4 will be near 17 divided by 3; that is, less than 6 (as 5·1 is) Again, 2·392 divided by 4·6, is not far from 2 divided by 4, or a half (which is nearly ·52)

Ex. 1. Divide ·1734 by 3·4.
Here ·1734 contains four decimals, and 3·4 one; the quotient 51 (Ex. 1, above) contains only two figures, and three are required, hence 51 must be written 0·051.

Ex. 2. Divide 2·392 by 46.
Here 2·392 contains three decimals, and 46 none; the quotient (52) must contain three, and becomes 0·052.

Ex. 3. Divide 27·9 by 0·02. Annexing one cipher, the quotient is 1395.

Ex. 4. Divide 0·0296 by 5·2. Annexing two ciphers gives quotient 569, which is 0·00569, since the five in this added to one in 5·2 make up six.

30. The division may always be carried to any degree of accuracy by annexing ciphers to the dividend, as is seen in Ex. 2, No. 28.

31. The decimal point may be removed altogether from both the divisor and dividend, by continually multiplying each by 10; for the quotient will thus remain unaltered, No. 7. The first decimal in the quotient will then appear only with the first cipher annexed to carry on the division.

Ex. Divide 27·9 by 0·02. Multiplied by 10 they become 279 and 0·2; multiplied again they become 2790 and 2, the quotient of which is 1395.

This easy process furnishes a complete security against wrongly placing the decimal point in the quotient.

[4.] *Reduction.*

32. The great convenience of decimals makes it often desirable to reduce vulgar fractions to the decimal form.

To reduce a Vulgar Fraction to a Decimal Fraction.

Divide the numerator by the denominator, adding ciphers as required. The quotient is the decimal required.

Ex. 1. Reduce $\frac{1}{5}$ to a decimal fraction. Dividing 10 by 5 (the cipher being added) we find $\frac{1}{5}$ is 0·2.

Ex. 2. Reduce $\frac{1}{3}$ to a decimal fraction. Dividing 10 by 3 gives 3; the next cipher added gives another 3, and so on continually. The fraction required is therefore 0·333, &c.

Ex. 3. Find what decimal of 1 (nautical) mile is 700 feet.

There are 6080 feet, nearly, in 1 such mile; hence 1 foot is $\frac{1}{6080}$ of 1 mile, and 700 feet are $\frac{700}{6080}$ of 1 mile, which gives 0·115 of 1 mile, nearly

Ex. 4. Find what decimal of 1 minute is 42 seconds.

1 second is $\frac{1}{60}$ of 1 minute, hence 42 seconds are $\frac{42}{60}$ or 0·7 of a minute; or, as it may be written, $0^{m}\cdot7$.

Ex. 5. Find what decimal of 1 foot is $8\frac{3}{4}$ inches.

First, $\frac{3}{4}$ is 0·75 of 1 inch, hence $8\frac{3}{4}$ inches are 8·75 inches. Then, 1 inch is $\frac{1}{12}$ of 1 foot hence 8·75 inches are $\frac{8\cdot75}{12}$, or 0·729, of 1 foot.

Ex. 6. Find what decimal of 1 degree is 8′ 37″.

37″ are $\frac{37}{60}$ of 1′, or 0·61 of 1′; then 1′ is $\frac{1}{60}$ of 1°; hence 8′·61 are $\frac{8\cdot61}{60}$ of 1°, or $0^{\circ}\cdot143$.

Ex. 7. Find what decimal of 1 day is $3^{h}\ 42^{m}$.

42^{m} are $\frac{42}{60}$ of 1^{h}, or $0^{h}.7$; and 1^{h} is $\frac{1}{24}$ of 1 day; hence $3^{h}\cdot7$ is $\frac{3\cdot7}{24}$ of 1 day or $0^{d}\cdot154166$, &c.

33. Or, reduce the given quantity to the lowest of its denominations when there are more than one, and also the integer to which it is referred, to the same denomination; then divide the given quantity by the integer thus reduced.

Ex. 1. (Ex. 3, above.) The given quantity, 700 feet, being all in one denomination, requires no further reduction.
The integer 1 mile, reduced to the same denomination, is 6080 feet; then 700 divided by 6080 gives 0·115.

Ex. 2 (Ex. 5, above.) 8 inches and 3 quarters are 35 quarters; and 1 foot reduced to the same denomination, is 48 quarters; then 35 divided by 48 gives 0·729

34. To reduce a Decimal Fraction to a Vulgar Fraction.

Note the number of parts which the unit or integer of the given quantity contains of the next inferior denomination, and multiply the given decimal by this number; the product is the given quantity expressed in that denomination

If this product have a decimal part, multiply this decimal by the number of parts which the unit of the present denomination contains of the next inferior denomination to that just before employed: this product is the quantity which the given decimal contains of that *next denomination.*

Proceed (if there till be decimals), in like manner, to the lowest denomination in which the decimal is required to be expressed

Ex. 1. Find the number of feet in 0·115 of 1 mile.

The next inferior denomination to that of miles is here feet, of which the number in 1 mile is ...... 0·115 × 6082

Ans. (in the lowest denomination required) 699·4 feet.

Ex. 2. Find the number of seconds in 0·7 of 1 minute.

The next inferior denomination to that of minutes is seconds, of which the number in 1 minute is ...... 0·7 × 60

Ans. 42·0 seconds.

Ex. 3 Find the number of inches and eighths in 0·48 of 1 foot.

The next inferior denomination to that of feet is inches, of which the number in 1 foot is ...... 0·48 × 12

5·76 inches.

The next proposed inferior denomination to inches is eighths, of which the number in 1 inch is 8

6·08 eighths.

Ans. 5 inches and 6·08 eighths, or $\frac{6}{8}$ nearly.

Ex. 4. Find the number of minutes and seconds in 0°·734.

The next inferior denomination to that of degrees is minutes, of which the number in 1° is ...... 0·734 × 60

44′·040

The next inferior denomination to minutes is seconds, of which the number in 1′ is 60

2·400

Ans. 44′ 2″·4.

Ex. 5 Find the number of hours and minutes in 0·37 of a day.

The next inferior denomination to days is hours, of which the number in 1 d. is 24 ...... 0·37 × 24

8·88 hours.

The next inferior denomination to hours is minutes, of which the number in 1h is 60 60

52·80 minutes.

Ans. $8^h\ 52^m{\cdot}8$.

35. When we propose to use the nearest whole number, rejecting the decimals, if the decimal is less than ·5, we omit it, if greater than ·5, we count it as a unit. For example, if we propose to take 31·3 as a whole number, we call it 31; if we propose to take 31·7 as a whole number, we call it 32. The reason is, obviously, that 31·3 is nearer to 31 than it is to 32, whereas 31·7 is nearer to 32 than it is to 31.

In like manner, we may abridge the decimals themselves when accuracy is not required: thus, for ex. 11·567 may, when two places only are required, be written 11·57, or when one place only, 11·6 *

II. Proportion.

36. By the term *ratio* we commonly understand the relative mangnitude or quantity of two things of the same kind; thus, when we speak of the ratio of two numbers, 12 and 4, we mean their relative magnitude, or the result of comparing them together in respect of quantity.

37. The most distinct and intelligible notion which we can form of the degree in which one quantity or magnitude is greater than another, is the number of times one contains the other; that is, the quotient of one by the other is the *measure* of the ratio. Thus, to compare 12 and 4, we find that 12 contains 4 three times, or the quotient $\frac{12}{4}$, or the number 3, is the measure of the ratio of 12 to 4.†

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* The following signs, or symbols, of arithmetical operations are often used for abbreviation.

(1.) The sign +, called *plus* (which is the Latin for *more*), signifies *additive*, or to be *added*.

(2.) The sign −, called *minus* (which is the Latin for *less*), signifies *subtractive*, or to be *subtracted*.

Ex. + 3 signifies 3 to be *added*, − 3 signifies 3 to be *subtracted*

(3.) The sign × signifies *multiplied by*.

Ex. 7 × 5 signifies 7 *multiplied by* 5.

(4.) The sign ÷ signifies *divided by*. The operation of division is also indicated by writing the divisor under the dividend, with a line between them.

Ex. 14 ÷ 2 signifies 14 *divided by* 2; which is as frequently denoted thus, $\frac{14}{2}$.

(5.) The sign = signifies *equal to* (or amounting to).

Examples of the preceding, with the results in each case, will stand thus:—

(1.) $14 + 3 = 17$, or $14 + 3 = 17$. (2.) $10 - 3 = 7$.

(3.) $7 \times 5 = 35$. (4.) $14 \div 2 = 7$, or $\frac{14}{2} = 7$.

These processes appear much more conspicuous to the eye than when written out in words at length.

† But, instead of saying that the absolute number 3 is the measure of the ratio 12 : 4, it is more correct to say that the measure is itself the ratio of 3 : 1; because, in all cases of measure, we employ a convenient quantity of the same kind as a unit, as 1 foot, or 1 mile, for length, 1 second for time, &c; so the measure of ratio is itself a ratio, but of the simplest form that can be found

The ratio or proportion (for the terms are often used indifferently) of two numbers, as 12 and 4, is written thus, 12 : 4, or, as above, $\frac{12}{4}$.

38. Suppose it required to find the ratio of 12 to 5. 12 contains 5 more than twice, but not three times. By actual division, $\frac{12}{5}$ gives $2\frac{2}{5}$; but this, instead of being simpler, is more complex than $\frac{12}{5}$. Hence, as we cannot simplify this fraction (12 and 5 having no common measure but 1), it remains as the measure, or represents the ratio of 12 : 5

39. In the same manner is represented the ratio of 4 to 12, in which the smaller term is taken first; for though 4 does not contain 12, yet it contains the third part of 12, so that there is still an exact relation between the numbers in this order: in other words, the ratio of 4 to 12 is the same as the ratio of $\frac{1}{3}$ to 1; but the ratio of $\frac{1}{3}$ to 1, or a third to the whole, is the same as that of 1 to 3, since each contains the other three times. Hence, 4 : 12, or $\frac{1}{3}$: 1, is the same as 1 : 3, or $\frac{4}{12}$ the same as $\frac{1}{3}$, which is the measure of $\frac{4}{12}$.

40. There is an employment of *ratio* or fractions which is often embarrassing to unpractised arithmeticians. If we increase 6 to 7, we add 1-*sixth*, for 1 is $\frac{1}{6}$ of 6, and 6+1 make 7; but, if we now diminish 7 to 6, we take away 1-*seventh*, for $\frac{1}{7}$ of 7 is 1, and 7−1 is 6. In the first case, we take a fraction of 6, in the second, a fraction of 7; and it is obvious that the same quantity cannot be the same fraction of two different numbers. In like manner 3 increased by $\frac{1}{3}$ of itself becomes 4; but to pass back again from 4 to 3, we must take away $\frac{1}{4}$ of 4.

41. It may be convenient to express the change of a quantity in any ratio, by means of the increase or diminution it undergoes, measured by a fraction of itself.

To increase a number in the ratio of $\frac{5}{3}$. $\frac{5}{3}$ is composed of $\frac{3}{3}$ and $\frac{2}{3}$, or 1 and $\frac{2}{3}$; hence the number is to be increased by $\frac{2}{3}$ of itself.

To diminish a number in the ratio of $\frac{4}{5}$. $\frac{4}{5}$ is equivalent to $\frac{5}{5}$, deducting $\frac{1}{5}$, or to $1-\frac{1}{5}$; hence the number is to be diminished by $\frac{1}{5}$ of itself.

Ex. 1. A number is increased in the ratio of $\frac{71}{53}$, by what fraction of itself is it increased? Answer, $\frac{18}{53}$.

Ex 2. A number is diminished in the ratio of $\frac{23}{51}$, by what fraction of itself is it diminished? Answer, $\frac{28}{51}$.

42. The first of two terms taken in order is called the *antecedent*, and the second the *consequent:* thus, in 12 : 4, 12 is the antecedent, and 4 the consequent; in 4 : 12, 4 is the antecedent.

1. *Direct Proportion.*

43. When two pairs of terms occur, each antecedent having the same ratio to its consequent, the four terms constitute an analogy, or proportion, as it is also called: thus, 18 and 6, 12 and 4, each pair

having for its measure the ratio $\frac{3}{1}$, form this proportion — 18 is to 6 as 12 is to 4; or, as it is written for abbreviation, 18 : 6 :: 12 : 4.

The same is also written thus: $\frac{18}{6} = \frac{12}{4}$, and read "the ratio of 18 to 6 is equal to the ratio of 12 to 4."*

44. In every proportion the product of the two extreme terms is equal to the product of the two mean (or middle) terms: thus, in 18 : 6 :: 12 : 4, $18 \times 4 = 6 \times 12 = 72$.† This property affords the test by which we learn the various alterations that may be made in a proportion, the original proportionality being still preserved.

45. The following variations in the order of the four terms of a proportion occur the most frequently:—

Given form,	18 : 6 :: 12 : 4				4 : 6 :: 12 : 18		
Alternately,	18 : 12 :: 6 : 4		In like manner,		6 : 4 :: 18 : 12		
Reversing,	6 : 18 :: 4 : 12				12 : 18 :: 4 : 6		
Or,	4 : 12 :: 6 : 18				12 : 4 :: 18 : 6		

46. In a proportion, either of the mean terms is equal to the product of the extremes divided by the other mean.

Thus in 18 : 6 :: 12 : 4, $6 = \frac{18 \times 4}{12}$, and $12 = \frac{18 \times 4}{6}$.

Also, either of the extremes is equal to the product of the means divided by the other extreme; as in

18 : 6 :: 12 : 4, $18 = \frac{6 \times 12}{4}$, and $4 = \frac{6 \times 12}{18}$

Hence, if any three terms of a proportion be given, the fourth may be found.

47. It is often required to increase or diminish a quantity in *a certain ratio*, or proportion. For example, to increase the number 12 in the ratio of 3 to 1, is to multiply by 3. For the increased quantity (which, being yet unknown, we will call x) is to be to the given quantity 12, as 3 to 1, or $x : 12 :: 3 : 1$. Whence (No. 44) $1 \times x = 12 \times 3$. Again, to reduce a number, as 13, in the ratio of 5 to 7, is to multiply it by 5 and then divide by 7, for the required number (x) is to be to the given number (13) as 5 is to 7, whence $x = \frac{13 \times 5}{7}$.

For example, if certain provisions last 122 men a given time, it is evident that, in order to last 146 men the same time, they must be *increased in the ratio* of 146 : 122; that is, multiplied by 146, and then divided by 122. Again, if certain provisions suffice 106 men, and they are required to serve only 74 men, they may be *diminished in the ratio* of 74 to 106; that is, $\times 74 \div 106$.

* Hence proportion is also described as being the equality of ratio.

† Hence, also, when the products of two pairs of numbers are equal, the four numbers may be written as a proportion. Ex. $22 \times 66 = 4 \times 363$; hence 22 : 4 :: 363 : 66. Care must be taken in the order of the terms, which, though indifferent in a product is every thing in a proportion.

[1.] *Rule of Three, Direct.*

48. Numerous arithmetical questions occur in a form more or less like this: if 5 men do 20 yards of work, how many yards will 11 men do, in the same time, and under the same circumstances.*

(1.) The most obvious and natural method of solving such questions is the *Method of Unity*. Thus, if 5 men do 20 yards, 1 man alone will do 4 yards, and therefore 11 men will do 11 times 4 yards.

(2.) The *General Method* is to arrange the terms in the manner of a proportion, and then to find the unknown term from the other three, (No. 46). Thus, it is obvious that a constant proportion obtaining between the men and their work, we have

5 men : 20 yards :: 11 men : number of yards required.

This process is called the Rule of Three.

(3.) They, however, who are practically familiar with ratio, or proportion, perceive, on considering the question, the ratio in which one of the given terms is to be changed, so as to suit the conditions; and thus the solution is effected at a single step. Thus, in the above question, it is evident that the given number of yards, 20, is to be increased in the ratio of 11 : 5; that is, in exactly the same ratio as the number of men is increased. The solution, therefore, is comprised in these figures, $20 \times \frac{11}{5}$, which gives 44.

49. Various precepts have been suggested for ensuring a correct order in the arrangement of the terms, or the *statement of the question*, as it is called; and one of such, which is often useful, is t. consider the terms given as standing to each other in the relation of cause or agent, and effect (as, for instance, the men in the above example and their work). By this supposition (which, however, is arbitrary and unsatisfactory enough in many cases), the four terms are rightly *paired*, or the antecedents and consequents rightly taken. But the fact is, that no mechanical rules can so completely supersede the notion of proportionality as to absolve the mind from all necessity for estimating it; and, consequently, the student, if he clearly understands proportion, depends upon it alone; and if he does not, he cannot, from any number of precepts, feel the least confidence in the soundness of his result.

As a right apprehension of proportion is most essential to every one who has any thing to do with calculation, we have, for the sake of exercise, solved several examples in each of the above three forms.

Ex. 1. A steam-vessel consumes 13 tons of coal in $1\frac{3}{4}$ days; how long will 98 tons last?

(1.) Method of Unity: 13 tons in $1\frac{3}{4}$d. or $\frac{7}{4}$d., is 1 ton in $\frac{7}{4 \times 13}$ or $\frac{7}{52}$d., and 98 tons in $98 \times \frac{7}{52}$ or $13\frac{5}{26}$ days, or 13d. 5h. nearly.

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* In the application of the rules which follow, the circumstances are supposed to remaio the same, that is, the change of the numbeis does not imply any other change If, for example, the increased number of men should be in each other's way, so as to interfere with their labour, this must be made a separate consideration.

(2.) General Method: 13 : $1\frac{3}{4}$d. :: 98 : d. req. $= 1{\cdot}75 \times 98 + 13 = 13{\cdot}2$ days.

(3.) By Ratio: Here $1\frac{3}{4}$ (days) is to be increased in the ratio of 98 to 13.

$$1{\cdot}75 \times 98 \div 13 = 13{\cdot}2.$$

Ex 2 If 13 men make 420 yards in 20 days; how much will they make in 11 days?

Note.—The number of men remaining the same, while the time and the work change, need not be noticed.

(1.) 420 yds. in 20 d. is 21 yds. in 1 d., and 11×21, or 231 yds. in 11 days.

(2.) 420 yds. : 20 d. :: yds. req. : 11 yds req. $= 11 \times 420 \div 20 = 231$ yds.

(3.) Here 420 is to be diminished in the ratio of 11 to 20.

Ex. 3. A pump, A, delivers 1 ton in 5^m; another, B, 1 ton in 8^m; and a third, C, 1 in 15^m: how much water will they deliver in $1^h\ 10^m$?

Ans. A, $\frac{70}{5} = 14$ tons; B, $\frac{70}{8} = 8{\cdot}7$; C, $\frac{70}{15} = 4{\cdot}7$. Total, 27·4 tons.

Ex 4. A boat, A, lands 52 men in 28^m (going and returning); another, B. lands 68 men in 41^m; and a third, C, lands 20 men in 23^m; how long will all take to land 220 men?

At these rates, in 1^h, A lands $\frac{60}{28} \times 52$ men $= 111{\cdot}4$; B, $\frac{60}{41} \times 68, = 99{\cdot}5$; and C, $\frac{60}{23} \times 20, = 52{\cdot}2$. Total in 1^h, 263·1 men. Now, as the number landed is proportionate to the time, we have $263{\cdot}1 : 1^h :: 220 : 220 \times 1 \div 263{\cdot}1$, or $0^h{\cdot}84$ nearly.

Ex 5. A boat, A, fills 8 tons of water in $3\frac{1}{2}^h$; another, B, fills 5 tons in 4^h; and a third, C, fills $1\frac{1}{2}$ ton in $1\frac{3}{4}^h$; in what time will they fill 107 tons?

(1.) In 1^h, A fills $\frac{16}{7}$ tons; B, $\frac{5}{4}$ tons; and C, $\frac{6}{7}$ tons; or altogether, $\frac{123}{28}$ tons. This is 1 ton in $\frac{28}{123}$ of 1^h, 107 tons in $28 \times 107 \div 123 = 24^h{\cdot}4$.

(3.) Having found the fraction expressing the joint effect for 1^h, or $\frac{123}{28}$ tons; 1^h is to be changed in that ratio, which will convert this into 1, ($\frac{28}{123}$ by Ex.), which gives the time for 1 ton; this is then to be increased in the ratio of 107 : 1.

Note.—Such questions as in Ex. 4 and 5 do not usually admit of exact solution; thus, in any whole number of trips that can be proposed, the boats carry too much or too little. Each boat performs a certain quantity in one particular interval of time, and not *continuously*, like a pump, or so much *per hour*: the reduction, therefore, to hourly rate, is not correct, but it is near enough for forming a tolerable estimate, which, in practice, is all that is wanted. To obtain as complete a solution as the question allows, we must take each boat's performance separately, and add them all up.

Ex.6. The change of the sun's declination in 1 day is 18′ 21″; find the change for $1^h\ 34^m$.

$$24^h\ (1440^m) : 18'\ 21''\ (1101'') :: 1^h\ 34^m\ (94^m) : x$$

or, less exactly, $24^h : 18'{\cdot}3 :: 1^h{\cdot}6 : x$.

Ex. 7. In a Table, against 36° stands the term 27943, and against 37° stands 28504; find the term corresponding to 36° 23′.

36°	27943
37	28504
Diff.	561

Hence 60 : 561 :: 23 . x

which *added* to 27943 (because the terms increase while the argument* increases), gives the term required.

Ex. 8. Against 11° in a Table stands 6726, and against 11° 30′ stands 6354; find the term corresponding to 11° 37′.

11° 0′	6726
11 30	6354
Diff.	372

30 : 372 :: 37 : x

to be *subtracted* from 6726, which gives the term required.

50. The process of finding a term which falls between two given terms, or, as it is called, *Interpolation*, is sufficiently exemplified above; but it is important to remark that it is not always necessary to work proportions at length. It is enough, for most practical

* The *argument* is the quantity at the side or head of the Table, for which the terms or quantities in the body of the table are given.

purposes, to take a quantity, somewhere between the given terms, as half way, or a third of the way, between them, according to the case. The power of guessing the proportional part is acquired by practice, and saves time which otherwise would often be wasted in working to a superfluous degree of accuracy.

On the other hand, when extreme precision is required, this proportioning alone is not enough, but a correction is necessary, for which see the explanation of the Table for finding the Equation of Second Differences.

[2.] *Double Rule of Three, Direct.*

51. Questions in the Rule of Three occur also in a more complex form; thus, if 2 men do 7 yards of work in 3 hours, how many yards will 13 men do in 11 hours? in which the answer is required to correspond not merely to a certain number of men, but also to a certain number of hours.

This question resolves itself into two: 1st, if 2 men do 7 yds. how many will 13 men do in the same time, or 3 hours? The answer to which is 45·5 yds.; and, 2nd, if 13 men do 45·5 yds. in 3 hours, how many yds. will they do in 11 hours? Hence the solution of such questions is called the Double, or Compound Rule of Three.

Ex 1. The example above

(1.) 1 man does $\frac{1}{2}$ of 7 yds., or 3·5 yds. in 3^h, and 13 men do 45·5 yds.
13 men do 45·5 yds. in 3^h, or 15·17 yds. in 1^h, and therefore 166·87 in 11 hours.

(2.) The two statements as given above.

(3.) 7 is to be increased in the ratio of 13 : 2, and then of 11 : 3.

Ex 2. If 9 men make 47 yds. in 4 days, how maoy yards will 17 men make in 31 days?
Ans. 688 yds.

Ex. 3. If 5 men do 64 yds. in 11 days, in how many days will 14 men do 37 yds.?

(1.) 1 man does 64 yds. in 55 days, or 1 yd. in 0·86 days, and
14 men do 1 yd. in ·86 ÷ 14, and 37 yds. in 2·27 days.

(2.) 5 m. : 64 yds. :: 14 m. : 179·2 yds. 179·2 : 11 :: 37 : 2·27 nearly.

(3.) 11 is to be diminished in the ratio of 37 : 64, and then of 5 : 14.

Ex. 4. A certain quantity of provisions lasts 170 men for 3 months; how much is required for 210 men for 2 months?

(2.) 170 : 1 (whole) :: 210 : x = 210 ÷ 170. And y : 210 ÷ 170 :: 3 : 2.

(3.) The quantity is to be increased in the ratio of 210 : 170, and diminished in the ratio of 2 : 3.

Ex. 5. A steam-vessel has fuel for steaming 13 days at 11 hours a-day; how much must she take to steam 15 days at 18 hours a-day?

(3.) The fuel must be increased in the ratio of 15 : 13, and then of 18 : 11. $\frac{15}{13} \times \frac{18}{11} = \frac{270}{143}$, which is $1\frac{127}{143}$, or $1\frac{8}{9}$ nearly, or nearly doubled.

Ex. 6. Three boats fill 16 tons of water in 7 hours; how many boats, at the same average performance, will fill 78 tons in 10 hours?

(1.) 3 boats fill 16 tons in 7^h, or $\frac{1}{7}$ of 16 = 2·3 tons in 1^h, and 23 tons in 10 hours. Then, since 23 tons employs 3 boats, 1 ton employs $\frac{3}{23}$ of 1 boat, and 78 tons will employ $\frac{78 \times 3}{23}$ or 10·2 boats.

(2.) 7^h : 16 t. :: 10^h : x tons (= 22·9) 22·9 t. : 3 b. :: 78 t. : 10·2 b.

(3.) 3 is to be increased in the ratio of 16 : 78, and then diminished in the ratio of 10 : 7.

2. *Inverse Proportion.*

52. In direct proportion, as we have seen, more is always followed by more, and less by less. But when the nature of the question is evidently such that *more* will be followed by *less*, or *less* by *more*, the proportion is no longer direct. For example, if 5 men do certain work in 4 days, in how many days will 7 men do the same work? Here it is evident that the *greater* number of men will require *less* than 4 days. Again, if a ship going 8 knots, sails a certain distance in 5 hours, it is evident that, if she goes at a *greater* rate, she will perform the same distance in *less* than 5 hours.

53. In a question of work performed, the result is represented by the number of agents multiplied by the time each works; thus, 6×5 or 30, represents the labour of 6 agents working for 5 hours, the unit of work being that performed by 1 man. If now, the work remaining the same, we double the number of agents, we shall obviously halve the time, since 12 men will do the work of 6 in half the time, and $12 \times 2\frac{1}{2} = 30$. Or, again, trebling the number of agents, gives $18 \times \frac{1}{3}$ of 5, or $18 \times \frac{5}{3} = 30$. That is, while one factor of a given product is *increased* in the ratio of 3 : 1, the other must be *diminished* in the ratio of 1 : 3, which last ratio contains the same terms as the other, but in a reverse or *inverted* order. The four numbers constituting two equal products are hence said to be in *inverse proportion* to each other

In the example, No. 52, the number of men is *increased* in the ratio of 7 : 5, and the time is accordingly to be *diminished* in the ratio of 5 : 7; hence 4 days becomes $4 \times \frac{5}{7}$, or $2\frac{6}{7}$ days.

[1]. *Rule of Three Inverse.*

54. In regard to the solution of these questions:

(1.) In the method of unity, the consideration of inversion does not present itself.

(2.) As a question of proportion, the solution may be effected thus. Suppose the proportion were direct, then (example above, keeping the antecedents and consequents in their given order) 5 men : 4 days : : 7 men : x days. Now, we require a direct comparison between the number of men in the two cases, and the times in the two cases; hence we alter this to 5 men : 7 men : : 4 days : x days. But this would give x greater than 4, as 7 is greater than 5, whereas we know it must be less; hence, inverting the last two terms, gives $5 : 7 :: x : 4$, or $7 : 5 :: 4 : x = \frac{4 \times 5}{7} = \frac{20}{7}$, or $2\frac{6}{7}$ days. Hence the process (which is, perhaps, as little liable to mistake as may be expected in a question of some perplexity), is, 1, to write, in the form of a direct proportion, the given antecedents and their consequents; 2, to close terms of like denomination; 3, to invert the last two terms, and then to find the unknown term.

Ex. 1. If 7 men do certain work in 4 days, in how many days will 10 men do it?

(1.) 7 men in 4 days is 1 man in 28 days, and 10 men in 2·8 days.

(2.) Direct form, 7 men : 4 d. :: 10 men : days required.
Like terms, 7 : 10 :: 4 : days required.
Inverting, 7 : 10 :: d. req. : 4. Ans. 2·8 days

(3.) It is evident that 4 is to be diminished in the ratio of 7 to 10.

Ex. 2. If 27 men do certain work in 14 days, how many men will do the same work in 4 days?

(1.) 27 men in 14 days, is 1 man in 378 days; and 378 ÷ 4 gives $94\frac{1}{2}$ men.

(2.) Direct form, 27 m. : 14 d. :: men req. : 4 d.
Closing like terms and inverting, men req. $= 27 \times 14 \div 4 = 94\frac{1}{2}$ men.

(3.) 27 is to be increased in the ratio of 14 : 4.

Ex. 3. If 12 men do certain work, working 4 hours a-day; how many men will it take to do the same work, working 7 hours a-day?

(1.) 12 men in 4 h. is 48 men in 1 h., and $\frac{48}{7}$ in 7 hours, or 7 men nearly.

(2.) Direct form. 12 m. : 4 h. :: men required : 7 h.
Closing like terms and inverting, $12 \times 4 \div 7 = 7$ men nearly.

(3.) 12 is to be diminished in the ratio of 4 : 7.

Ex. 4. Certain tons of fuel last a steam-vessel 11 days, steaming 4 hours a-day; how long will they last steaming $6\frac{1}{2}$ hours a-day?

(1.) 4 h. for 11 d. is at the rate of 1 h. a-day for 44 d., and therefore $6\frac{1}{2}$ h. for $44 \div 6\frac{1}{2}$, or $88 \div 13$, which is 6·77 d., or 6 d. $18\frac{1}{2}$ h.

(2.) Direct form, 11 d. : 4 h. :: x days : $6\frac{1}{2}$ h.
Closing like terms and inverting, $x = 44 \div 6\frac{1}{2} = 6{\cdot}77$ d.

(3.) Here 11 days is to be diminished in the ratio of 4 to $6\frac{1}{2}$.

Ex. 5. A certain quantity of fuel lasts a steam-vessel 12 days, steaming day and night; how long will it last steaming 14 hours a-day? Ans. $20\frac{4}{7}$ days.

Ex. 6. A pump, A, empties a cistern in 3 hours; another, B, in $2\frac{1}{4}$ hours; in what time will they empty it both working together?

(1.) In 1^h, A empties $\frac{1}{3}$ of it, and B empties $1 \div 2\frac{1}{4}$, or $1 \div \frac{9}{4}$, which is $\frac{4}{9}$. Hence in 1^h both together empty $\frac{1}{3} + \frac{4}{9}$, or $\frac{7}{9}$. Suppose, for greater convenience, the cistern to hold 10 tons; then in 1^h both empty $\frac{70}{9}$ tons, or 1 ton in $1^h \div \frac{70}{9}$, or $1^h \times \frac{9}{70}$, $= \frac{9}{70}$ of 1^h, which is 10 tons in $\frac{9}{7}$ of 1^h, or $1\frac{2}{7}^h$.

(2.) Stating the question directly, we should say,
$\frac{1}{3} + \frac{4}{9}$ $(= \frac{7}{9})$: the whole, or 1 :: time required : 1^h.
But, the greater the fraction representing the hourly work done, the smaller must be the time required for any given quantity of work.
Hence $\frac{7}{9}$: 1 :: 1^h : time required $= \frac{9}{7}$ of 1^h.

(3.) Here 1^h, in which the fraction $\frac{7}{9}$ is done, is obviously to be increased in that ratio which will turn $\frac{7}{9}$ into 1, or the whole; and this ratio is $\frac{9}{7}$, for $\frac{9}{7} \times \frac{7}{9} = 1$.

Ex. 7. A can do certain work in 8^h, and B the same work in 6^h; in what time will they both complete it together?

(1.) In 1^h A does $\frac{1}{8}$, and B $\frac{1}{6}$, hence both together $\frac{1}{8} + \frac{1}{6}$, or $\frac{7}{24}$. Let the work be represented by 10, then in 1^h both do $\frac{70}{24}$, and therefore they do the unit of work in $1^h \div \frac{70}{24}$, or $\frac{24}{70}$ of 1^h. Hence they do the whole in $10 \times \frac{24}{70} = \frac{24}{7}$ of 1^h, or $3\frac{3}{7}^h$.

(2.) Direct form, $\frac{1}{8} + \frac{1}{6}$: 1 (whole) :: time required : $1^h = \frac{24}{7}$.

(3.) 1^h is to be increased in the ratio of 24 : 7.

Ex. 8. Five pumps empty a cistern in 13 hours; how many must be put on to empty it in $3\frac{1}{2}$ hours?

(1.) 1 pump in 65 hours gives 18·6 in $3\frac{1}{2}$ hours.

(2.) 5 p. : 13^h :: x : $3\frac{1}{2}^h$. Ultimately, $x = 5 \times 13 \div 3{\cdot}5$.

(3.) 5 is to be increased in the ratio of 13 : $3\frac{1}{2}$.

Ex. 9. Four pumps empty a cistern in 10 hours; how long will 7 such pumps take?
Ans. $40 \div 7 = 5^h{\cdot}7$.

Ex. 10. A certain quantity of bread lasts 110 men 21 days; how long will it last 74 men?

(1.) 21 d. for 110 men is 1 d. for 2310 men, and $2310 \div 74$ gives 31·2 days.

(2.) Direct form, 110 m. : 21 d. :: 74 m. : x d.
Closing like terms and inverting, $x = 21 \times 110 \div 74 = 31{\cdot}2$ days.

(3.) It is evident that 21 is to be increased in the ratio of 110 : 74.

Ex. 11. A quantity of bread lasts a ship's crew 21 days at four-fifths allowance; how long will it last at two-thirds allowance?

(1.) $\frac{4}{5}$ lasts 21 d., $\frac{1}{5}$ will last 4×21 or 84 days, and $\frac{5}{5}$, or whole allowance, $\frac{84}{5}$ or 16·8 days. Hence $\frac{1}{3}$ allowance will last $3 \times 16{\cdot}8$ d., or 50·4 d., and $\frac{2}{3}$, one half of this, or 25·2 days.

(2.) $\frac{4}{5}$: 21 :: $\frac{2}{3}$ :: required days.
Closing and inverting, days required $= 21 \times \frac{4}{5} \div \frac{2}{3} = 25{\cdot}2$ days.

(3.) 21 days are to be increased in the ratio of $\frac{4}{5} : \frac{2}{3}$, that is $21 \times \frac{4}{5} \div \frac{2}{3}$.

Ex. 12. If it takes 54 yds. at $\frac{3}{4}$ of a yard wide, to cover a surface; how many yards will it take at $\frac{4}{5}$ of a yard in width?

(1.) 54 yds. at $\frac{3}{4}$ wide is 3×54, or 162 yds. at $\frac{1}{4}$ wide, or 40·5 yds. at 1 yd. wide. This is $5 \times 40{\cdot}5$ or 202·5 yds. at $\frac{1}{5}$ wide, and $\frac{1}{4}$ of this, or 50·62 yds. at $\frac{4}{5}$ wide.

(2.) Direct form, 54 yds. : $\frac{3}{4}$ width :: yds. req. : $\frac{4}{5}$.
Closing like terms and inverting, yds. req. $= 54 \times \frac{3}{4} \div \frac{4}{5} = 50{\cdot}62$ yds.

(3.) Here 54 is to be diminished in the ratio of $\frac{3}{4} : \frac{4}{5}$, or of 15 : 16.

[2.] *Double Rule of Three, Inverse.*

55. As the inversion arises from a product remaining constant while both factors vary, questions of this kind may be solved directly by taking, in each of the two proportions necessary, those terms only which are directly proportional to each other. For example, in a question of agents, work, and time, the first proportion would include work and time, and the second, agents and work.

III. Logarithms.

56. These are numbers calculated for the purpose of converting multiplication into addition, and division into subtraction.

1. *Use of Logarithms.*

57. Every logarithm consists of two parts, the *index* and the decimal part;* thus, in the logarithm 2·80618, the index is 2, and the decimal part ·80618.

58. *To find the Logarithm of a given number.* Find in the Table of Logarithms of Numbers the decimal part (for which see also the Explanation of that table); and then apply the index by one of the two following rules:—

(1.) When the number consists of a whole number, with or without decimals, the index is 1 less than the number of figures in the whole number.

* This part is also called the *mantissa.*

Ex. 1. Find the log. of 522.

Against 522, in the Table, stands ·717671; then, since there are three figures in 522, the index is 2; hence the log. is 2·717671.

Ex. 2. Find the log. of 5·22.

The log. of 5·22 is 0·717671, because there is one figure in the whole number, and one less than 1 is 0.

(2.) When the number consists of decimals only, count the number of ciphers between the decimal point and the first significant* figure after it, and subtract this number from 9; the remainder is the index.

Ex. 1. Find the log. of ·005814.

The decimal part of 5814 is ·764475; there are two ciphers before the 5, which 2 taken from 9 leaves the index 7: hence the log. is 7·764475.

Ex. 2. The log. of ·5814 is 9·764475, for the number of ciphers before the ·5 is nothing which leaves 9 for the index.

59. *To find the natural number of a given Logarithm.* Look for the decimal part of the given log. in the body of the table, and take out the number from the side column and top.

To place the decimal point. Add 1 to the given index of the log., and mark off to the left this number of figures; these will be whole numbers; the rest, if any, will be decimals.

If the index is 9, put the dot before the first figure; if it is 8, prefix one cipher to the first figure, and place the dot before the cipher; if it is 7, prefix two ciphers, and so on.†

Ex. 1. Find the number to the log. 1·717671.

The number (to 4 places) to ·717671 is 5220: adding 1 to the index 1, gives 2, which, marked off to the left, gives 52·2, the number required.

Ex. 2. Find the number to the log. 8·581381.

The number to 581381 is 3814; prefixing one cipher gives ·03814, the number required.

When the number exceeds four figures, see the explanation of the table.

60. In using logarithms, it is proper to observe that the number (whether it contain decimals or not), and the decimal part of the logarithm, are in general true to the same number of figures, rejecting prefixed ciphers; thus, for instance, the log. 3·7575 corresponds to the number 5721, and the log. 3·7576 to 5722, nearly. So also, 8·7575 to ·05721, and 8·7576 to ·05722.

This remark should be kept in view, because it is mere waste of time to employ more figures than are required to insure a certain degree of precision in the result.

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* That is, the first figure not a cipher.

† As the index of the log. is 1 less than the number of figures in the natural number itself, it would follow that the index of ·3814 (for example) in which there are no significant figures, would be 1 less than nothing, the meaning of which is, that such a log. is reckoned on the opposite direction from a certain point, which need not here be further discussed. The index of such a log. is called *negative*; and as this is embarrassing to beginners, 10 is added to the index 0, whereby 1 less gives 9. But 9 is the index, properly, of a number consisting of 10 figures; however, as we have no such numbers to deal with, the ambiguity of the double meaning is not experienced.

61. The remark (No. 35) applies also to logarithms, thus, for example, if we propose to use only four figures of the log. ·881385, we write ·8814, which is evidently nearer to ·881385 than ·8813 would be. Again, if we take four figures of ·881343, we write ·8813.

62. To find the *arithmetical complement* of any number or logarithm.

Take every figure from 9, except the last, which take from 10. It is necessary to begin at the left.

Ex. 1. Find the arith. comp. of	1·87043	Ex. 2. Find the arith. comp. of	0·91350
arith. comp. log. required	8·12957	arith. comp. log.	9·08650

63. A subtractive quantity is, by this means, made additive The process is equivalent to subtracting the number from 10, and the reason of it is evident on considering that to add 3, for example, and subtract 10, is the same as to subtract 7. In like manner, instead of subtracting $47^m\ 32^s$, for example, we may add $12^m\ 28^s$ (the complement to 60), provided we subtract 1 hour (or 60); and thus any number of quantities, of which some are additive and some subtractive, may be rendered all additive, provided that the larger numbers which are employed in taking the complements be themselves subtracted.

2. *Certain Arithmetical Operations by Logarithms.*

[1.] *Multiplication.*

64. To multiply numbers together, add their logarithms together; the sum is the logarithm of the product required.

Ex. 1. Multiply 530·9 by 27·22.		Ex. 2. Multiply ·079 by 3·142.	
530·9	log. 2·725013	·079	log. 8·897627
27·22	log. 1·434888	3·142	log. 0·497206
Ans. 14451.	log. 4·159901	Ans. 0·2482	log. 9·394833

[2.] *Division.*

65. From the log. of the dividend subtract the log. of the divisor; the remainder is the log. of the quotient required.

If the logarithm of the dividend is the lesser of the two, increase its index by 10.

Ex. 1. Divide 4280 by 365.		Ex. 2. Divide 69·3 by 71·7.	
4280	log. 3·631444	69·3	log. (+10) 1·840733
365	log. 2·562293	71·7	log. 1·855519
Ans. 11·73	log. 1·069151	Ans. 0·9665.	log. 9·985214

[3.] *Involution.*

66. Involution is the process of multiplying a quantity by itself: the quantity thus multiplied is said to be *raised to a power*.

67. The *first power* is the number itself. The second power is the number multiplied by itself; this is also called the *square*. The third power is the number again multiplied by itself; this is also called the *cube*.

The number or quantity to be raised to a power is called the *root*; the number which indicates the power to which the quantity is raised is called the *index*.

68. To *square* a number. Multiply the log. of the number by 2; the product is the log. of the number required.

When the number is a decimal fraction, subtract the index (after being doubled) from 10 multiplied by 2 (or 20), diminish the remainder by 1, and prefix the number of ciphers indicated by this remainder to the number corresponding to the logarithm.

Ex. 1. Square 12·39.

12·39	log. 1·093071
	2
Ans. 153·5.	log. 2·186142

Ex 2. Square ·0592.

·0592	log. 8·77232
	2
Ans. ·003505	log. 17·54464

17 from 20 leaves 3; deducting 1 gives 2; 2 ciphers are, therefore, prefixed to 3505.

69. To *cube* a number. Proceed by the above rule, only reading 3 for 2, and 30 for 20. In like manner, to raise a number to the *fourth power*, read 4 for 2, and 40 for 20, and so on.

[4.] *Evolution.*

70. Evolution is the reverse of involution, and is the process of finding that number which, multiplied by itself a certain number of times, will produce the given number.

This number is called the *root* of the given number.

71. To extract the *square root* of a number. Divide the log. of the given number by 2, the quotient is the log. of the square root required.

When the given number is a decimal fraction (that is, when the index of its logarithm is 9, 8, 7, &c.), increase the index by 10.

Ex. 1. Find the square root of 1·535.

1·535	log. 0·186108
	2)0·186108
1 239 Sq. root req.	0·093054

Ex. 2. Find the square root of ·003505.

·003505	log. 7·54469
	10
	2)17·54469
0·0592 Sq. root req.	8·77234

72. To extract the *cube root*. Proceed by the above rule, only reading 3 for 2, and 20 for 10. To extract the *fourth root*, read 4 for 2, and 30 for 10, and so on for other roots.

IV. Practical Geometry.

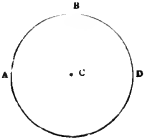
1. *Definitions.*

73. Geometry is the name of that science which relates to the measures of space.

A problem is something required to be done.

Parallel lines are lines so placed that the shortest distance between them is every where the same, as A B, C D. Such lines evidently never meet.

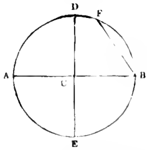
74. A **circle** is a figure bounded by a curve line called the *circumference*,* of which every point is at the same distance from a point within, called the *centre*. Thus, A B D is a circle, and C the centre.



75. The circumference is divided into 360 equal parts, called *degrees*, written thus, 360°; each degree, into sixty equal parts, called minutes (60′); each minute into sixty seconds (60″); and also each second, into sixty thirds (60‴). Example, 11° 19′ 46″, eleven degrees, nineteen minutes, forty-six seconds.

76. The circumference is also divided into 32 equal portions of 11° 15′ each, called *points of the compass*. These are again subdivided into half points and quarter-points. The term point is used indifferently for the *arc* of 11° 15′, and for a mere point of division of the circumference.

77. A straight line, A B, drawn through the centre, divides the figure into two equal parts, called *semicircles*, as A D B, A E B. The half circumference measures 180°.



78. The line A B is called the *diameter:* it is evidently equal to twice the distance from the centre, C A, which is called the *radius*.

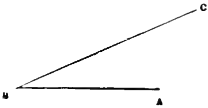
---

* In common language, circle and circumference are often used indifferently the one for the other, but circle is properly the *surface* or *area* of the figure included within the circumference.

79. If another diameter, D E, cross this, and divide each semicircle into two equal parts, the four equal parts, A D, B D, B E, E A, are called *quadrants*, and each of such portions of the circumference measures 90°.

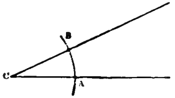
80. Any portion of the circumference is called an *arc*, and the line joining its extremes is called a *chord:* thus the line B F is the chord of the arc B F.

81. An ANGLE is the inclination of two straight lines to each other; that is, the difference of the directions in which they lie: thus A B C, or B, is the angle contained by the two lines B A, B C which are called the *legs*.



An angle is not changed by increasing or diminishing the length of the legs, because the *length* of these lines has nothing to do with the *directions* in which they lie.

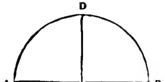
82. Since in describing a circle the radius moves round the centre C, exactly as the point of the compasses advances on the circumference, the angle A C B is measured by the number of degrees in the arc A B.



83. The arc A B is said to *subtend* the angle A C B.

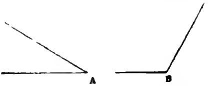
84. An angle of 90°, as A C D (fig. in No. 77), which is subtended by a quadrant, as A D, is called a *right* angle. A circle contains four right angles, a semicircle two.

85. The angles A C D, B C D, being each 90°, are equal; and C D, which makes these adjacent angles equal, is said to be *perpendicular* to A B.



86. The difference between an angle and 90° is called its *complement;* the difference to 180° is called its *supplement.*

An angle less than 90° is called *acute*, as **A**.
An angle greater than 90° is called *obtuse*, as **B**.



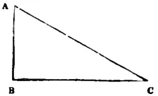
87. A PLANE TRIANGLE is a figure contained by three straight lines.

When the three sides are equal, the triangle is called *equilateral*; when two of them are equal, it is called *isosceles*.

88. When one of the angles is 90°, the triangle is said to be *right-angled*; when each angle is less than 90°, it is said to be *acute-angled*; when one is greater than 90°, it is said to be *obtuse-angled*.

Triangles that are not right-angled are called in general *oblique-angled*.

89. In a right-angled triangle, as A B C, the side A C, opposite the right angle is called the *hypothenuse*; one of the other sides, as B C, is called the *base*; and the third side, A B, the *perpendicular*.



90. A SPHERE, OR GLOBE, is a solid figure bounded by a curve surface, of which every point is at an equal distance from the centre.

2. *Geometrical Problems.*

91. The instruments necessary in constructing the figures in these problems are, a pair of compasses and a straight edge of any kind, as of a ruler, or, when such cannot be had, the back of the fold made by doubling a piece of thick paper. Also the parallel rulers are convenient. These may be of the common form, which needs no description here, or those called Marquoi's Rulers.*

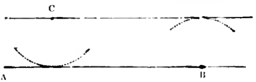
92. The accuracy of a straight edge is tested thus. Draw a line with a fine pointed pencil, or steel pen, along the edge, between two points near the extremities. Then turn the ruler over and draw another between the same two points: if the edge is perfect, the two lines will appear as one; if not, there will be a space between them.

* These last consist of a right-angled triangle, having one of its angles about 20°, and a flat ruler somewhat longer than the hypothenuse of the triangle, both of the same thickness. By sliding the triangle along the edge of the ruler, which is kept fixed, two sides of it move parallel to themselves. This parallel motion is perfect, which is not always the case with the common parallel rulers, especially after long use; and besides this, the triangle being right-angled, dispenses with the trouble of drawing perpendiculars by points.

93. PROBLEM. To draw a line through a given point parallel to another line.

C is the given point, A B is the line.

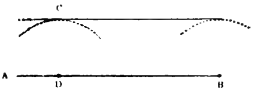
Take the shortest distance from C to A B in the compasses; set one foot on A B as at B, and describe a small arc; then the line drawn through C, so as to touch this arc, is the line required



94. PROBLEM. To draw a line parallel to another line at a given distance from it.

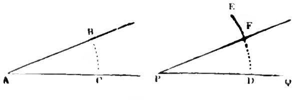
A B is the line, C D the given distance.

Take C D in the compasses, place one foot near each end of A B, and describe two arcs; the line drawn touching these arcs is the line required.



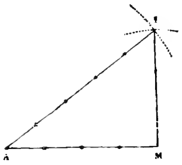
95. PROBLEM. At a given point in a line to make an angle equal to a given angle.

P is the point in the line P Q; A is the given angle. From the centre A, with any convenient radius (the longer the more accurate), describe an arc, C B; from the centre P, with the same radius, A B, describe an arc, D E; take the distance from C to B in the compasses, and put one foot on D and the other on the arc at F, and join P F: then the angle F P D is equal to B A C, their measures, F D and B C, being the same.



96. PROBLEM. From a point M, in a straight line A M, to draw a perpendicular to it (fig. p. 26).

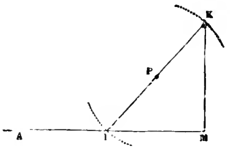
(1.) Draw a straight line any where, and set off by the compasses 5 equal parts upon it. With 3 of these parts in the compasses, as radius, describe from M, as a centre, an arc at I; then lay off 4 parts from M to A; with 5 parts, as radius, describe from the centre A an arc cutting the former arc at I; join I M: this is the perpendicular required.



The following methods are also used :

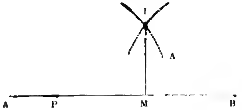
(2.) When the point M is at or near the end of the line.

Take a point P, such that a line supposed to join P and M may make the angle P M A about 45° ; and from P as a centre, with the radius P M, describe a small arc I, and another opposite, as K, draw the line I P K, and join the point where it crosses the arc K with M. K M is the perpendicular required.



(3) When the point M is not near the end of the line.

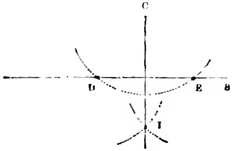
Take two points P, B, at equal distances, from M, and at P and B as centres with a radius exceeding P M, describe two arcs, cutting each other at I ; join I M. This line is the perpendicular required.



97. Problem. From a given point without the line, as C, to draw a perpendicular to it.

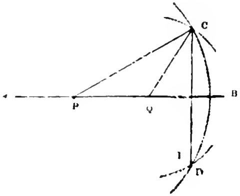
(1.) When the point is nearly opposite the middle of the line.

Take in the compasses a distance exceeding the distance from C to the line; and from C, as a centre, describe an arc, D E; then, from D and E as centres, with a convenient radius, describe two arcs cutting each other at I. C I is the perpendicular required.



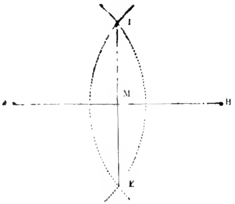
(2.) When the given point is towards the end of the line.

Take a point P as centre, and with P C as radius describe an arc C D. Take another point Q as centre, and with Q C as radius describe another arc cutting C D in I. C I is the perpenaicular required.



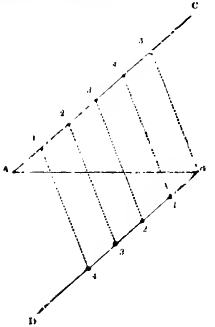
98. PROBLEM To bisect a line A B, or to divide it into two equal parts.

Take in the compasses a distance exceeding half the line, and from A and B, as centres, describe two arcs. The line I K, joining the points of their intersection, divides the line A B into two equal parts, A M, M B.



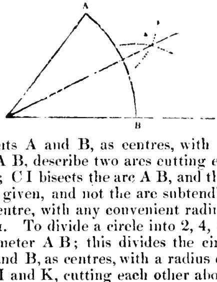
99. PROBLEM. To divide a line, A B, into any proposed number of equal parts, as five, for example.

Draw a line A C, making about half a right angle with A B. Draw another line, B D parallel to A C. On A C and B D lay off five equal parts; join the points 1 and 4, 2 and 3, &c.; these lines will divide A B into 5 equal parts.



In like manner, the line might be divided into any other number of equal parts.

100. PROBLEM. To bisect an arc A B, or an angle A C B.

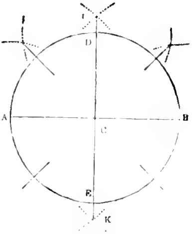


From the points A and B, as centres, with a radius exceeding half the distance A B, describe two arcs cutting each other in I, and draw the line C I; C I bisects the arc A B, and the angle A C B. If the angle alone is given, and not the arc subtending it, describe this arc from C as a centre, with any convenient radius.

101. PROBLEM. To divide a circle into 2, 4, 8, &c. equal parts.

Draw the diameter A B; this divides the circle into two equal parts. From A and B, as centres, with a radius exceeding half A B, describe the arcs I and K, cutting each other above and below A B; join I K: the line E D is a diameter crossing A B at right angles, and dividing the circle into the four quadrants, A E, E B, B D, and D A. Bisect the arc A D (No. 100); draw the diameter through C: this will bisect B E also. Bisect, in like manner, B D and A E. The circle is now divided into 8 equal parts, of 4 points each; bisecting these last arcs divides the circle into 16 equal parts, of $22°\frac{1}{2}$ each.

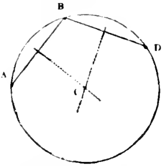
and again bisecting these divides it into the 32 points of the compass of $11^\circ\frac{1}{4}$ each.



An arc is divided into a number of parts not divisible by 2, as into 3, 5, 7, &c. parts, by trial.

102. PROBLEM. To find the centre of a circle, or circular arc.

Take two points, as A B, on the circumference, and join them; bisect the line A B (No. 98), and at the middle point draw a perpendicular (No. 96, 3d). Take a third point, D, join it with B; bisect the line B D, and draw a perpendicular at the middle point. The two perpendiculars will cross at the centre.



103. PROBLEM. To draw a circle through three given points.

Suppose the three points to lie in a circle, and proceed to find the centre as above.

It is easy to see that however three points may be placed, some one circle will always pass through them; for an infinite number of circles may be drawn passing through two points, and therefore some one of these must likewise pass through a third point wherever situated.

3. *Use and Construction of the Scales.*

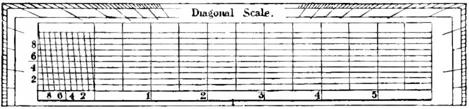
104. These are flat, thin pieces of brass, ivory, or wood divided into certain portions by lines, and serve for measuring or laying off lines or *distances*, and *angles*.

The common scale of equal parts has generally on one side four or five different scales for different measures, on each side of which one division is subdivided into 10 equal parts.

105. In the diagonal scale, the shorter lines dividing the length into equal portions (units) are crossed perpendicularly by 10 others extending the length of the scale. The end division, or unit, has its upper and lower edge subdivided into 10 equal parts, and diagonal lines are drawn from the beginning of one division to the end of the opposite one. This effects a further subdivision by 10, as an example will shew. To take the No. 5·28 from this scale by the compasses. Set one foot at 5, and the other at the second line on the lower edge of the subdivided unit,—this gives 5·2. Now follow up the diagonal line at the ·2 to the eighth of the long parallel lines, and, fixing the point there, extend the other point to meet the line which rises at 5, crossing the breadth; and the number is taken.

The same process serves for tens and units, as for units and tenths, and so on; thus the No. 52·8, or 528, is taken as above.

By placing the points of the compasses *between*, instead of *on*, the 10 long parallel lines, we may obtain a still further subdivision.

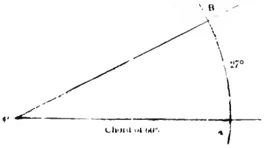


106. Angles are measured, or laid off, either by means of the lines marking the divisions of degrees, or half degrees, at the edge of the scale, and which are numbered at each 10° or 5°, or by means of the

Scale of Chords.

(1.) To measure an angle by the marked divisions. Place the middle point of the scale (which is strongly marked) upon the angular point, and lay the edge along one of the legs; the other leg, produced, if necessary, shews, on the graduated edge, the degrees which the angle contains.

(2.) To measure an angle by the scale of chords. Take in the compasses the chord of 60° off the scale, and describe an arc: take the distance from A to B in the compasses, and, placing one foot at



the beginning of the scale of chords, look how many degrees the other foot extends to. Thus, for example, if A B extends to 27°, the arc A B, or angle, C, contains 27°.

107. To lay off an angle from a given line, as, for example, 27°. Describe an arc A B (fig. 106), with the chord of 60°, from C, as centre, and set off the chord of 27° from A on A B; join C B, and A C B is the angle required.

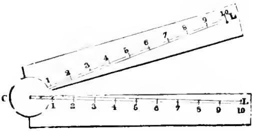
When the angle to be measured or laid off exceeds 90°, measure or lay off 90°, and then the excess above 90°.

108. The semicircle with a graduated edge is useful for this purpose; but the most convenient instrument, especially for using with the chart, is a transparent horn semicircle, with a long silk thread attached to its centre.*

109. To construct a scale of chords to any proposed radius. The radius is equal to the chord of 60°; describe, therefore, a quadrant, divide it into portions of 30°, 20°, 10°, and so on; draw the several chords, and transfer them to the proposed scale.

4. *The Sector.*

110. The Sector is a ruler, or scale, which folds into half its length by moving round a large circular joint on which it is accurately centered. Several lines, or scales, are laid off from the centre to the extremity on both legs of the sector, as tangents, sines, &c., and others parallel to the edges. We shall refer here only to that one which is called the *line of lines* (marked C L in the figure), on account of the great convenience of the sector in reducing a plan, or a figure, to another on a different scale, dividing lines proportionally,† and in solving some simple questions which depend on proportion alone.



The line of lines is divided into 10 equal parts, and these again are similarly subdivided. The distance from the centre to any point in the line of lines is called the *lateral distance;* and that between any point in the line of lines on one leg, and the corresponding point on the other, the *transverse distance.*

* Such semicircles, made of horn or other transparent material, and having a long silk thread attached to the centre to extend a straight line to any point beyond the circumference, are most useful, especially for chart work. They are commonly called protractors.

† Another instrument, equally convenient and portable, but more expensive, is the *proportional compasses.* These compasses open on a movable centre, so that the opening of one pair of points may, by moving the centre, be made to bear any proportion to the opening of the other pair of points.

The following examples will illustrate the use of the Sector.*

Ex. 1. To divide a line into a number of equal parts, as for ex. 7.

Take the given line in the compasses; place one point on the division 7 on one leg of the sector, and open it till the other falls on the other 7. Then the transverse distance 1 to 1 is 1-7th, 2 to 2 is 2-7ths, and so on; or the line 7, 7 is equally divided into the parts 1, 1; 2, 2; &c.

Ex. 2. To reduce a plan on the scale of 3 inches to a mile, to another scale of 2 inches to a mile.

Take the lateral distances on the scale of the 3-inch plan. Take 2 in the compasses; place one point at the division 3, and open the sector till the other point falls on the other 3. Then the transverse distances will be the distances on the proposed plan.

Ex. 3. A line of a given figure measures 85; find the measure of another line in the same figure.

Take the given line 8 5 in the compasses and open the sector till their points measure the transverse distance 8 5, 8·5. Then any other line of the figure taken in the compasses is measured by finding the corresponding points in the two legs which exactly contain it, and multiplying the number shewn by 10.

* *See* J. F. Heather on Mathematical Instruments, Lockwood & Co., Ludgate Hill.

V. Raising the Trigonometrical Canon

111. This term implies forming the proportions or analogies proper for the solution of problems concerning right-angled triangles.

Before, however, the student proceeds to the actual composition of these analogies, he should be acquainted with the few propositions of geometry which are given in the following section.

112. Definition. An Axiom is a proposition assumed to be so obvious as to require no demonstration.

The principal axioms which have been employed as the foundation of geometrical reasoning are the following:—

(1.) Geometrical magnitudes are said to be equal when one being placed on another coincides with, or exactly covers, it.

(2.) Two magnitudes which are each equal to a third, are equal to each other.

(3.) If equals be added to equals, the wholes will be equal.

That is, if two magnitudes be equal, and a third be added to each, the two sums will be equal.

(4.) If equals be taken from equals, the remainders will be equal.

(5.) If the same or equal quantities be added to unequals, the sums will be unequal.

(6.) If equals be taken from unequals, the remainders will be unequal.

(7.) The halves of equal things are equal.

(8.) The doubles of equal things are equal.

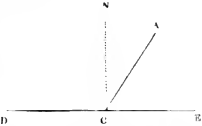
113. Def. A Geometrical Theorem is a proposition in which some property of a figure is demonstrated.

The term Proposition includes both Problems and Theorems.

114. Def. A Corollary is an obvious conclusion or necessary inference, from a proposition.

1. *Theorems of Geometry.*

115. A straight line, as A C, standing on another, as D E, makes the adjacent angles, A C E and A C D, together equal to two right angles.

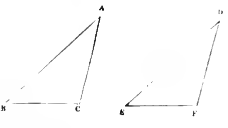


For, draw C N at right angles to D E; then D C N and N C E are two right angles; that is, D C N, with N C A and A C E, are two right angles; and since D C N and N C A make up D C A, therefore, D C A and A C E are two right angles.

116. If two straight lines, as A B, C D, intersect or cross each other, the opposite and vertical angles, as C E A, B E D, are equal.

Since C E stands on A B, the angles C E A and C E B are equal to two right angles (No. 115). Again, since B E stands on C D, the angles C E B and B E D are equal to two right angles. Hence C E A and C E B are equal to B E D and C E B. Take away the angle C E B, common to both these sums, and the remaining angles C E A, B E D are equal. (No. 112, 4).

117. If two triangles, as A B C, D E F, have two sides of the one, as A B, A C, equal to two sides of the other, as D E, D F, and have likewise the angles A, D, contained by those sides, equal, the two triangles are equal in all respects.



For if the point A be laid on D, and the line A B on D E, the point B will coincide with E because A B is equal to D E.

Also, since the angles A, D, are equal, the line A C will coincide with D F, and the point C of A C will coincide with the point F of D F, because A C is equal to D F.

Then since B coincides with E, and C with F, the base B C coincides with the base E F, and is therefore equal to it.

Since therefore the three sides of the triangles are equal, the triangles are equal, and either laid on the other (two equal sides being laid on two equal sides) will exactly cover it. Hence the two remaining angles must be equal, or B is equal E, and C to F; or, the triangles are equal in all respects.

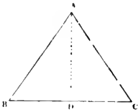
The above proves the method No. 100. For suppose A and I, B and I to be joined by lines, then the two triangles C A I, C B I, have the sides C A, A I equal to C B, B I, and the third side common. Hence they are equal, and the angles A C I, I C B being equal, each is half of A C B.

118. If two triangles A B C, D E F (fig. No. 117) have the angles B, C, in one, equal to two angles E, F, in the other respectively, and also the sides B C, E F, adjacent to the equal angles, equal to each other, the two triangles are equal.

Suppose the point B to be laid on E, and the side B C on E F, the points C and F will coincide because B C is equal to E F.

Again, since the angles B and E are equal, the side B A will fall on E D; and because the angles C and F are equal, the side C A will fall on F D. Hence, as the point A belongs to both the sides B A and C A, and D to E D and F D, the point A will coincide with D, and the angles A and D are equal. Hence the two triangles are equal.

119. In an isosceles triangle, as A B C, the angles B, C, opposite the equal sides A B, A C, are equal.



Suppose the angle B A C bisected by the line A D. Then since A B and A C are equal, and the side A D common to the two triangles A D B, A D C, and the angle B A D equal to C A D, each being half of B A C, these two triangles are equal in all respects (No. 117), and therefore the angles B and C are equal.

Cor. 1. Since the base B D is equal to the base C D, a line bisecting the angle contained by the two equal sides of an isosceles triangle likewise bisects the third side.

Cor. 2. Also, since the adjacent angles A D B, A D C are equal, they are right angles, or the said line is perpendicular to the third side.

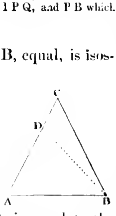
Cor. 3. If the third side is equal to A B or B C, the angle A is equal to B or C; or an equilateral triangle is equiangular.

This proves the method No. 97 (1); for supposing C D, D I, and C E, E I joined, the two C D, D I are equal to C E, E I, and C I is common; hence the triangles are equal. And the angles D C I, E C I are equal, and each is half D C E; hence C I bisects D C E and is perpendicular to A B.

The like proof applies to No 97 (2); for suppose P I, Q I to be joined; then C P, C Q are equal to P I, Q I, and P Q is common; hence C P Q is equal to I P Q, and P B which thus bisects C P I, is perpendicular to C D.

The same kind of proof applies to Nos. 96 (3) and 98.

120. Every triangle which has two angles, A, B, equal, is isosceles: or the sides C A, C B are also equal.

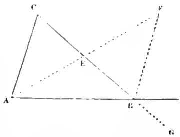


If C A is not equal to C B, let it be greater, and take a part of A C, as A D, equal to C B.

Then since D A, C B are equal, add to each of them A B, and the two D A, A B, are equal to the two C B, A B (No. 112, 3). Also, since D A is equal to C B, the angles D A B, C B A are equal (No. 119). Hence the triangle A D B, having the two sides D A, A B, and the included angle D A B equal to the sides C B, A B, and the angle C B A, is equal to the triangle C B A (No. 117), or the less to the greater, which is absurd. Hence A C, C B are not unequal, that is, they are equal.

Cor. If the third angle C is equal to A or B, the side A B must in like manner be equal to C B, or to C A; that is, every equiangular triangle is equilateral.

121. If a side of a triangle A B C, as A B, be produced, the exterior angle C B D is greater than either of the interior and opposite angles A and C.

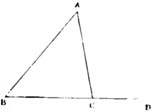


Bisect C B in E, join A E and produce the line till E F is equal to A E; and join F B.

Then since A E is equal to E F, and B E to E C, and also the angle A E C to the angle B E F, the two triangles A E C, B E F have two sides and the included angle equal in each. Hence these two triangles are equal (No. 117), and therefore the angle C (opposite the side A E) is equal to the angle E B F (opposite the equal side E F). Hence C B D which contains C B F is greater than C.

In like manner, by producing C B to a point G, and bisecting A B, it would be proved that the angle A B G, or its equal C B D, is greater than A.

122. Any two angles of a triangle are together less than two right angles.



Produce the side B C of the triangle A B C, to D. Then the exterior angle A C D of the triangle is greater than the interior and opposite angle A B C (No. 121). Add to each angle A C B, then A C D and A C B, are greater than A C B and A B C (No. 112, 5); and since A C D, A C B are equal to two right angles, A C B, and A B C are less than two right angles. The same may be proved of the other angles by producing the other sides.

123. If a straight line A B meeting two other lines C D, E F, makes the alternate angles C G H, G H F equal, the two lines are parallel.

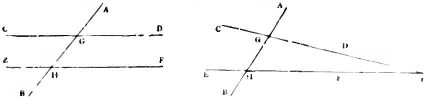


Fig. 1. *Fig. 2.*

For if they are not, they will meet on one side of A B; let them meet at I, then G H I is a triangle, and the exterior angle C G H is greater than the interior and opposite angle G H F (No. 121). But these angles are equal by the supposition, therefore the lines do not meet towards I.

In like manner it may be shewn that they do not meet on the other side of A B, and hence that they do not meet at all; that is, they are parallel.

It appears by fig. 2, that the lines meet on that side on which the two interior angles are less than two right angles. For I G H, I H G are together less than two right angles (No. 122).

124. If a straight line A B (fig. 1, No. 123) falling on two lines C D, E F, make the exterior angle A G D equal to the interior and opposite angle G H F (on the same side of A B), the two lines are parallel. Also, if the two interior angles D G H, G H F, are equal to two right angles, the lines are parallel.

The angle A G D is by supposition equal to G H F, and A G D is equal to C G H (by No. 116); hence C G H and G H F are equal, and they are alternate angles, and C D, E F are parallel.

Again, since D G H, G H F are equal to two right angles by the supposition, and since C G H, D G H are equal to two right angles by No. 115, C G H, D G H, are equal to D G H, G H F; take away the common angle D G H, and the remaining angle C G H is equal to G H F, and they are alternate angles, therefore C D, E F are parallel.

125. If a straight line A B (fig. 1, No. 123) fall on two parallel lines C D, E F, it makes

(1.) The alternate angles C G H, G H F, equal;

(2.) The exterior angle A G D equal to the interior and opposite angle G H F;

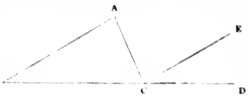
(3.) The two interior angles D G H, G H F, equal to two right angles.

(1.) If C G H be not equal to G H F, let it be greater; add to each the angle D G H; then the angles C G H, D G H are greater than the angles D G H, G H F, and C G H, D G H are equal to two right angles (No. 115); therefore D G H, G H F are less than two right angles. But, by fig. 2, No. 123, this is the case in which the two lines meet at I, whereas they are here parallel by the supposition; therefore C G H is not greater than G H F. In like manner it might be shewn that it is not less; it is therefore equal to G H F.

(2.) Since A G D is equal to C G H (No. 116), and C G H to G H F, therefore A G D is equal to G H F.

(3.) Hence, adding D G H to A G D, G H F, the two A G D, D G H are equal to the two D G H, G H F. But A G D, D G F are equal to two right angles; therefore D G H, G H F are equal to two right angles.

126. Prop. The exterior angle, as A C D, of a triangle (formed by producing one of the sides of the triangle), is equal to the sum of the two interior and opposite angles, A B C and B A C.



Produce the side BC to D, and draw C E parallel to B A. Then the angle E C D is equal to A B C since B D meets the parallels B A and C E (No. 125). Again, the alternate angles B A C, A C E, formed by A C, which crosses the same parallels, are equal (No. 125). Hence A C E and E C D are together equal to B A C and A B C; that is, A C D, which is made up of A C E and E C D, is equal to B A C and A B C.

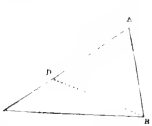
127. **Prop.** The three interior angles of a triangle are together equal to two right angles (fig. No. 126).

By the above proposition, A C D is equal to the sum of A B C and B A C. Add to each A C B; then A C D and A C B are equal to the three angles A B C, B A C, and A C B, (No. 112). But A C D and A C B are equal to two right angles, therefore the angles A B C, B A C, and A C B, are equal to two right angles.

Cor. 1. In a triangle which has one right angle, the other two angles make up a right angle; each of them, therefore, must be less than a right angle, and each is the complement of the other to 90°.

Cor. 2. If two triangles have two angles in the one equal, respectively, to two angles in the other, they will also have the third or remaining angles equal.

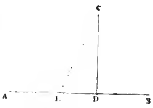
128. **Prop.** The greater side of any triangle, as A C, is opposite to the greater angle A B C.



C A being greater than A B, make A D equal to A B, and join D B; then since A D is equal to A B, the triangle A B D is isosceles, and the angles A D B and A B D are equal (No. 119). But A B D which is contained within A B C is less than A B C. Hence A D B is less than A B C. Now A D B is equal to the sum of A C B and C B D (No. 125); hence A D B is greater than A C B, that is A B D is greater than A C B, therefore A B C is greater than A C B.

In like manner, by taking C D equal to C B, it would be proved that the angle B is greater than the angle A; and, by taking D on B C, and B D equal to B A, that the angle A is greater than the angle C.

129. **Prop.** The line drawn perpendicularly from a given point C, to a right line A B, as C D, is the shortest that can be drawn from C on A B.



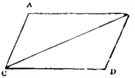
Take any point E in A B, and join C E. Then since in the triangle C E D, C D E is a right angle, the angle C E D is less than a right angle (No. 127, Cor. 1), and therefore (No. 128) C E is greater than C D.

The same proof applies to any point whatever taken in A B.

Cor As the angle C E D is acute, wherever E may be taken, there is but one line which can be drawn perpendicular to A B from C.

130. Def. A Parallelogram is a four-sided figure of which the opposite sides are parallel.

131. The opposite sides of a parallelogram, as A B, C D, are equal; also the opposite angles are equal; and the diameter, or diagonal. C B divides it into two equal parts.



Since A B and C D are parallel, and C B meets them, the alternate angles A B C and B C D are equal (No. 125). Also, since A C, B D, are parallel, and B C meets them, the alternate angles A C B, C B D are equal. Hence the two triangles A B C, B C D having two angles equal in each, and the side B C adjacent to them common, are equal (No. 118). Hence A B is equal to C D, and A C to B D; also the third angle A to the third angle opposite, D.

Since the two triangles are equal, and make up the whole figure, each is half the parallelogram, or C B bisects A D.

132. The straight lines C A, B D (fig. No. 131) which join the extremities of two equal and parallel lines A B, C D are themselves both equal and parallel.

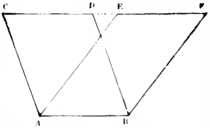
The triangles A C B, C B D, having the two sides A B, C D equal, and the side B C common, and also the included angles A B C, B C D equal, are equal; hence A C and B D are equal.

Again, since the other angles are equal, A C B and C B D are equal, and hence A C, B D are parallel.

This proves the method No. 93; for the equal distances laid off from C and B perpendicular to A B, form two sides of a parallelogram, of which the other sides also are parallel.

And the like reasoning applies to No. 94.

133. Parallelograms, as A B C D, A B E F, on the same base A B and between the same parallels A B, C F, are equal to each other.

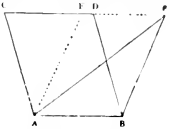


Since C D and E F are each equal to A B, they are equal to each other. Add to each D E, then C D, D E, are equal to E F, D E (No. 112, 3), or C E is equal to D F. Also A C is equal to B D, and A E to B F, hence A C, C E are equal to B D, D F, and the angles A C E, B D F, are equal, because A C is parallel to B D (No 125). Hence the triangle A C E is equal to the triangle B D F (No. 117).

Take away the triangle A C E from the whole figure A B C F, and the remainder is A E F B; again, take away the triangle B D F from the same figure, and the remainder is A B C D; therefore since these triangles are equal the remainders are equal (No. 112, 4), or the parallelograms A B C D, A B E F are equal.

Cor. Parallelograms on equal bases, and between the same parallels, are equal. For since the bases are equal, either of them placed on the other will coincide with it, and the above proof applies.

134. A Parallelogram A B C D is double of a triangle A B E on the same base, A B, and between the same parallels, A B, C E.

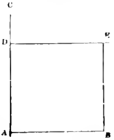


Draw A F parallel to B E, then A B F E is a parallelogram, and it is equal to A B C D (No. 133). Hence the triangle A B E, which is half of A B E F, is equal to half A B C D, or the parallelogram is double of the triangle.

Cor. Triangles on the same or equal bases, and between the same parallels are equal. For parallelograms under these two conditions are, by No. 133, and Cor, equal, and the triangles being the halves of equal parallelograms, are equal.

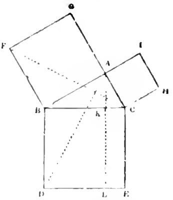
135. Def. A Square is a four-sided figure of which all the sides are equal, and all the angles right angles.

136. Prob. To describe a square, A E, on a given line, A B.



Draw A C perpendicular to A B, take A D equal to A B, and through D draw D E parallel to A B; and through B draw B E parallel to A D (or take D E equal to A B, and join B E). Then A D E B is a parallelogram, of which the opposite sides, being equal, are each equal to A B. Also since D E is parallel to A B, and A D meets them, the angles E D A, D A B, are equal to two right angles, and since A is a right angle, D is a right angle, and the opposite angles to these being equal to them are also right angles.

137. In any right-angled triangle, as A B C, the square B E, on the hypothenuse B C, is equal to the sum of the squares G B and C I on the other two sides.



Draw A K L perpendicular to B C, or parallel to B D, which is perpendicular to B C, and join F C and A D.

Then, since B D is equal to B C, and F B to B A (No. 135), the two sides F B, B C are equal to the two A B, B D (No. 112, 3). Also, the angles A B D and F B C are equal, since each contains a right angle and the common angle A B C Hence the triangles A B D and F B C are equal (No. 117).

Now the triangle A B D is half the parallelogram B L, because they are on the same base B D, and between the same parallels B D, A L (No. 134). Likewise the triangle F B C is half the square B G, since G C and F B are parallel. Hence the parallelogram B L and the square B G are equal.

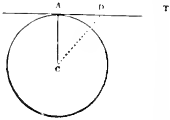
In like manner, by joining the points B H, and A, E, it would be proved that the parallelogram C L and the square C I are equal.

Hence the sum of the squares B G, C I, is equal to the sum of the parallelograms B L, C L, that is, to the square B E.

Hence in a right-angled triangle if we have two sides we can always find the third: thus, suppose the hyp. is 100, and the base 64, the squares of these are 10000, and 4096; the diff. of these squares, or 5904, is therefore the square of the unknown side, which is 76·8.

The theorem above proves that the triangle of the dimensions in No. 96 (1) is right-angled For 3, and 4, squared, are 9 and 16, and the sum of these, or 25, is the square of 5, the third side.

138. The perpendicular on the extremity of the radius of a circle, as A T, is a tangent to the circle.



Take any point D in A T, and join C D; then since C A D is a right angle, C D A is less than a right angle (No. 127), and therefore C D is greater than C A (No. 128) or falls beyond the circumference, that is, A T touches the circle at A only.

Cor. As only one line can be perpendicular to A T (No. 129), the centre of the circle must be in the line perpendicular to the tangent.

139. The angle at the centre of a circle, as A C B, is double the angle at the circumference, as A D B, both angles standing on the same arc A B.

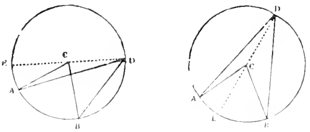


Fig. 1. *Fig.* 2.

Join D on the circumference and C the centre, and produce the line D C to E; then the exterior angle A C E of the triangle A C D is equal to the sum of the two interior and opposite angles C A D, and C D A (No. 126). But C A D is equal to C D A, because C A and C D being equal, A C D is an isosceles triangle (No. 119). Hence A C E at the centre is equal to twice A D E at the circumference.

Again, the exterior angle B C E of the triangle B C D is equal to the sum of C B D and C D B. But these angles also are equal, because C B and C D being equal, C B D is an isosceles triangle; hence B C E at the centre is equal to twice B D E at the circumference.

Now, in fig. 1 (where the diameter of the circle passes clear of the arc A B), A C B is the difference of B C E and A C E, and is double of A D B, the difference of B D E and A D E.

When E falls on A B, as in fig. 2, A C B is the sum of A C E and B C E, and is double the sum of the angles A D E and B D E, or the angle A D B.

140. The angle at the circumference is measured by half the arc subtending it (fig. No. 139).

As A C B at the centre is measured by the arc A B, it is evident that A D B at the circumference (which, by the prop. is half A C B) is measured by half A B. Thus, if A B is 58°, the angle A D B will be 29°, for any point of the circumference at which D may fall, except between A and B.

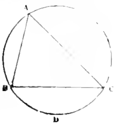
This proves the method No. 100, for, since C A, A I (supposing A, I, and B, I, joined) are equal to C B, B I, and C I common, the triangles C A I, C B I are equal,—hence A C I and I C B are equal; each therefore is half of A C B, and is measured by half the arc A B.

141. The angle in a semicircle is a right angle.

If the arc A B increases to a semicircle, A moving to E and B to D, A C and C B (fig. 1, prop. 139) falling into the same line, form a diameter, the angle A C B becomes two right angles or 180°, and then A D B, or half A C B, is 90°. Hence the angle in a semicircle is a right angle.

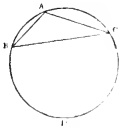
This theorem proves the method No. 96 (2), for since I K is a diameter, the angle at M, a point on the circumference, is the angle in a semicircle.

142. The angle in a segment greater than a semicircle is less than a right angle.



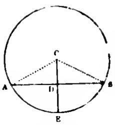
The segment B A C of the circle being greater than a semicircle, the other segment B D C must be less than a semicircle; and the angle B A C in the greater segment being measured by half the arc B D C, that is, by a quantity less than half 180° (No. 140), is less than a right angle.

143. The angle in a segment less than a semicircle is greater than a right angle.



The segment B A C being less than a semicircle, the segment B D C must be greater than a semicircle, and therefore the angle B A C, which is measured by half B D C (No. 140) is greater than half two right angles or than one right angle.

144. A line, C D, drawn from the centre of a circle bisecting any chord A B, is perpendicular to the chord.



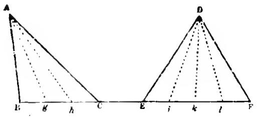
Join C A, C B, then C A and C B are equal by the def. of a circle (No. 74). Also A D and D B are equal, each being half of A B, and C D is common to the two triangles C A D, C B D. These triangles, therefore, having their three sides equal, are equal; hence the equal angles C D A, C D B, opposite the equal sides C A, C B, being adjacent angles, are right angles.

Cor. The line from the centre bisecting the chord bisects the arc **A B.** For since the two triangles, as above, are equal, the angles A C D and B C D, opposite the equal sides A D, D B, are equal, and being at the centre are measured by the arcs on which they stand.

The above proposition is the principle of the method of finding the centre of a circle, No. 102.

145. Triangles having the same altitude are proportional to their bases.

The altitude is the perpendicular distance of the vertex, or summit, from the base.



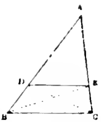
Let the base B C of the triangle A B C be divided into any number of equal parts, as three, B *g*, *g h*, *h* C, and E F the base of the triangle D E F, into four like parts, E *i*, *i k*, *k l*, *l* F, then B C is to E F as 3 to 4.

Join the points A *g*, A *h*, and D *i*, D *k*, D *l*. Then the triangles A B *g*, A *g h*, A *h* C, and D E *i*, D *i k*, D *k l*, D *l* F are all equal, being on equal bases, and having the same altitude (No. 134, Cor.)

Hence the triangle A B C contains three parts, of which D E F contains four, and, therefore A B C : D E F :: 3 : 4, which is the ratio of the bases.*

146. A line D E parallel to a side B C of a triangle A B C divides the sides A B, A C, in the same proportion, that is, A D : A B :: A E : A C.

* If it be impossible to find a quantity, or measure, B *g*, which shall divide B C and E F into an exact number of equal parts, as 3 and 4 above (that is, when B C and E F are said to be incommensurable) we must take a smaller quantity, and a greater number of triangles; and by taking this measure sufficiently small we may make the error of using it instead of the true proportion as small as we please.



Join B E, C D Then the triangles B D E, C D E on the same base D E, and between the same parallels D E, B C, are equal (No. 134, Cor.) Add to each the triangle A D E, then the whole triangle A B E is equal to the triangle A D C (No. 114, 3). Hence the triangle A B E : A B C :: A D C : A B C.

Now triangle A B E : triangle A B C :: base A E : base A C, since they have the same altitude, viz the perpendicular drawn from B on A C or A C produced (No. 145). Also,

triangle A D C : triangle A B C :: base A D : base A B,

And the triangle A B E is equal to the triangle A D C, hence the two proportions are the same, and A E : A C :: A D : A B.

In like manner, as the triangles A D E, E D B, have the same altitude, viz. the perpendicular drawn from E on A B, we have

triangle A D E : triangle E D B :: A D : D B.

Also since the triangles A D E, E D C have the same altitude, viz. the perpendicular from D on A C,

triangle A D E : triangle E D C :: A E : E C.

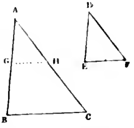
But the triangles E D C and E D B are equal, hence

A D : D B :: A E : E C.

This proof applies to the sector. The line of lines on each leg is the side of an isosceles triangle, and the transverse distances 1,1, 2,2, &c., are the bases of so many isosceles triangles; the angles at these bases being equal, the bases are parallel, and the sides of the several triangles so formed are proportional.

147. Def. Similar triangles are such as have the sides about the equal angles proportional.

148. Equiangular triangles, as A B C, D E F, have the corresponding sides about the equal angles proportional, that is, A B : A C :: D E : D F.



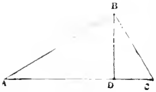
Let the angles A and D be equal, as also B and E, C and F.

Place the triangle D E F on A B C, D being placed on A, and D E on A B, and let G be the point where E falls.

Then since the angles A and D are equal, and D E is on A B, D F will fall on A C; let, therefore, H be the point where F falls. Then since A G H is equal to E, and B to E, A G H is equal to B, and the lines G H and B C, which make equal angles with A B, are therefore parallel. Hence, by No. 146, A B : A C :: D E : D F.

Cor. Hence equiangular triangles are similar (No. 147.)

149. In a right-angled triangle A B C, a line B D drawn from the right angle perpendicular to the hypothenuse, divides the triangle into two similar triangles A B D, B D C.



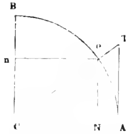
The triangles A B C, A D B, having each a right angle, and the angle A common, have the third angle also equal (No. 127), they are, therefore, equiangular.

For the like reasons A B C and B D C are equiangular; therefore the two triangles A B D, B D C, are equiangular, and the sides about the equal angles are proportional (No. 148). Hence

(1) A C : A B :: A B : A D.
(2) A C : C B :: C B : C D.
(3) A B : A D :: B C : B D.*

2. *Terms of Trigonometry.*

150. These terms occur in all calculations in which lines and angles are concerned.



151. P N C is a right-angled triangle; a quadrant is described with the radius C P, from the centre C; C N and C P are produced, and A T is drawn parallel to P N.

152. The perpendicular P N, drawn from the extremity of the arc A P, upon the radius C A, is called the *sine* of the angle P C A (to which it is *opposite*).

When the arc is very small, or P very near A, P N and A P, or the arc and sine, nearly coincide. When the arc is 0, the sine is 0. When the arc is 90°, P falls at B, or the sine of 90° is equal to the radius. Thus the sine is always less than the radius, though near 90° it becomes very nearly equal to it.

153. The line C N, between the centre and the foot of the sine, is called the *cosine* of P C A (to which it is *adjacent*). It is called cosine because its equal P n, is the *sine* of P C n, the *complement* of P C N.

When the arc is small, N falls near A, and C N falls nearly on C A, or the cosine of a small arc is nearly equal to the radius; for the arc 0, they are equal. When the arc is near 90°, the cosine is very small; and the cosine of 90° is 0. Thus the cosine is always less than the radius, though it may approach indefinitely near to it.

---

* By (1) A C × A D = A B × A B, or, as it is written, A B², and read A B square; and by (2), A C × C D = C B²; hence the products A C × A D and A C × C D are together equal to A B square and B C square. But A C × A D and A C × C D, is the same as A C × A D and C D, or as A C × A C, which is called A C square; hence A C square is equal to A B square and B C square. The term square here denotes the number of units (in the line) multiplied by itself; thus, if A B is 3, A B² is 9, and this is the number of square units contained in the square described on A B. Hence this is another form of the propos. in No. 137.

154 The line A T, drawn from the extremity of one radius (as C A), touching the circle, and meeting the other radius produced, is called the *tangent* of the angle P C A, or arc P A.

When the arc is small, A T but little exceeds P N; when the arc is 0 the tangent is 0; when the arc is small, the tangent and sine may be taken for each other, and for the arc. When the arc is 90°, the tangent is infinitely great. The tangent is less than the radius, according as the angle is less or greater than 45°.

The *cotangent* is the tangent of P C n, which is the complement of P C N, and would be drawn from the extremity of the radius C B, meeting C P produced.

155 The line C T meeting the tangent, is called the *secant*.

The *cosecant* is the secant of P C n, and meets the cotangent.

When the arc is 0, the secant is equal to the radius. When the arc is 90°, the secant is infinitely great. The secant is always greater than the radius, as is also the cosecant.

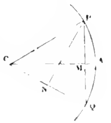
156. The line A N is called the *versed sine*.

157. These quantities are calculated for a radius of the same constant length, and to each minute or smaller division of the quadrant, and are inserted in Tables. Then, since the sides of all right-angled triangles having the same angles are proportional (No. 148), the tables afford the means of finding the relations among the parts of a right-angled triangle, of any kind or dimensions, by simple proportion. For example, the sine of 30° is ½ the rad. (see No. 159, Cor.), or 0·5, the log. of which, by No. 58 (2), is 9·698970, as inserted in Table 68.

These are the principles on which the Traverse Tables and the Trigonometrical Tables are constructed.

3. *Propositions of Trigonometry.*

158. The sine of an arc is half the chord of twice the arc.



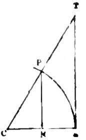
Take the arcs A P, A Q equal to each other, and join P Q. Then the angles P C A, A C Q are equal (No. 82). And since C P = C Q, and C M is common to the two triangles C P M, C Q M, these triangles are equal (No. 117): hence P M = M Q; therefore P M, the sine of A P, is half P Q, the chord of twice A P.

159. The chord of 60° is equal to the radius.

Let A P and A Q (fig. No. 158) be each 30°, then the arc P Q is 60°; and since the three angles of the triangle P C Q are equal to 180° (No. 127), C P Q and C Q P are together equal to 120°. Also, since C P = C Q, these two angles are equal (No. 119), and each, therefore, is 60°. The triangle is, therefore, equiangular, and consequently, equilateral, No. 120. Hence P Q = C P.

Cor. Since P M is half P Q, it is equal to half C P; or the sine of 30°, which is the cosine of 60°, is half the radius.

160. The secant of 60° is equal to twice the radius.



Since P N and A T are both perpendicular to C A, they are parallel (No. 124), and the triangles C P N, C T A, are similar (No. 148), hence

C T : C P :: C A : C N, that is, as rad. : cos. 60°, or as 1 to $\frac{1}{2}$, that is, as 2 : 1.

161. The tangent of 45° is equal to the radius.

Let P C A (fig. No. 160) be 45°, then C T A is also 45° (No. 127), hence the triangle is isosceles and the sides C A, A T are equal.

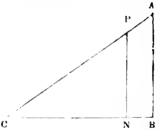
Cor. Hence also, by similar triangles, C N = N P, or the sine and cos. of 45° are equal; as are also the tangent and cotangent.

4. *Constructing the Canons, and working them by Logarithms.*

162. Take a right-angled triangle, as A B C, and suppose another similar to it, as P N C, drawn in a quadrant, as in No 151; then

C A : A B :: C P : P N;

that is, C A : A B :: rad. : sin C (by 152).



The second triangle, P N C, is, in fact, here referred to for illustration only; for it is evident, without it, that C A and A B themselves stand in the same relation to each other as that of *radius* and *sine*; hence

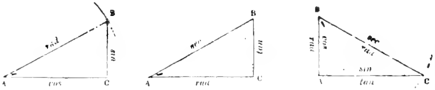
By No. 152. C A : A B :: rad. : sin. C. (1.)
By No. 153. C A : C B :: rad. : cos. C. (2.)
By No. 154. C B : B A :: rad. : tan. C. (3.)
By No. 155. C B : C A :: rad. : sec. C. (4.)*

163. It is easy to recollect these analogies, each of which begins with two sides, by observing these conditions.

1. One of the three sides must be made radius, and the analogy always begins with that side.

2. The other sides will then become sine, cosine, tangent, cotangent, secant, or cosecant, of one or the other of the two acute angles.

The figures below sufficiently illustrate the application of the terms.



* The learner will much more speedily apprehend the purposes which the expressions of trignometry answer in the sciences of calculation by considering these proportions as representing the change of quantities in a certain ratio, as in No. 48 (3). Thus A B is C A *diminished* in the ratio of the sine of C to 1; C B in that of cosine to 1. A B is also C B *diminished* or *increased* in the ratio of tan. to 1, according as C is less or greater than 45° and C A is C B *increased* in the ratio of secant to 1.

To employ rightly the terms *sine*, *cosine*, &c., observe—

3. That when the *hypothenuse*, or longest side (which is opposite the right angle), is made the radius,

The side *opposite* either of the acute angles is the *sine* of that angle; and the side *adjacent* to either angle is the *cosine* of that angle.

4. When either of the sides containing the right angle (or *legs*,* as they are called), is made radius, the other side becomes the *tangent* of the angle *opposite* to it; and the hypothenuse becomes the *secant* of that angle which is contained or included between *itself* and the *radius*.

The learner should be able to construct the above analogies (which he will find very easy) before he proceeds to the solution of any question, without regard to what is given or what is not given.

164. We now proceed to the calculation of a problem. The above analogies or proportions consist of four terms each. Hence, if three are given, the fourth may be found (No. 46). But the radius is assumed in the trigonometrical tables as 1 (which is the simplest of numbers), and hence, of the three remaining terms, if two are given, the third may be found.

Hence, in any right-angled triangle, consisting of three sides and two angles besides the right angle, if two parts which enter into any one of the above analogies are given, the third term of that analogy may be found.

165. The proportions may be solved by multiplication and division; thus, suppose, C A (fig. No. 162) measures 37 feet, and the angle C is 29° 52′, and we want to find A B.

We have by No. 162 (1), C A : A B :: 1 : sin. C,

whence (No. 46) A B = C A × sin. C (the 1 not being written).

Now the sine of 29° 52′, given in tables of natural sines (of which the *logs*. are given in Table 68) is 0·498 nearly, hence A B = 37 × 0·498 = 18·426.

But in order to save such tedious processes, logarithms are employed in the manner described, Nos. 64 and 65. Thus, A B = 37 × sin. C, becomes log. of A B = log. of 37 + log. sin. C.

Again, if C A were required, and A B given, we should have C A = A B × 1 ÷ sin. C; or, (suppressing the 1),

log. C A = log. A B − log. sin. C.

The following rules are deduced from these principles.

The learner will do well to verify all his work by the Traverse Tables. This proceeding is described in the explanation to the Traverse Tables.

166. The rule for working any analogy by logarithms is very simple, and there are but two cases: 1. In which it is required to find one of the mean terms; and, 2. In which it is required to find one of the extreme terms.

---

* The two legs are also called the *base* and *perpendicular* (No. 89). These terms, being usually given to the sides which are horizontal and vertical, as the reader holds the figure before him, are employed entirely at convenience.

(1.) To find a *mean* term. Add together the logarithms of the two extremes, and subtract from the sum the logarithm of the other mean. The remainder is the logarithm of the term required.

(2.) To find an *extreme* term. Add together the logarithms of the two means, and subtract from the sum the logarithm of the other extreme. The remainder is the logarithm of the term required.*

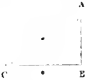
Note.—The log. of the *radius* (as employed in the analogies) is 10, this being used for convenience, as stated at p. 19, note †.

Case I. Given the angles and the hypothenuse, to find the two sides.

Ex. B is the right angle. The angle A is 50° (whence C is 40°, because the two acute angles are together 90°. (See No. 127, Cor.) C A is 28 feet. It is required to find B C and B A.

We must employ two sides, and one of them must be the unknown, or required side; hence,

to find C B,
we must take C A and C B.



If C A, the hypothenuse, be radius, C B becomes the sine of A (No. 163), hence

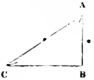
C A : C B :: rad. : sin. A;

in which C B, a *mean* term, is required. Hence, by No. 166 (1), we have to add the logs. of C A and sin. A, and subtract the log. 10.

C A 28	log. (tab. 64)	1·4472
A 50°	log. sin. (tab. 68)	9·8843
	log.	11·3315
	sub.	10·
C B = 21·4	log.	1·3315

We might have used C B as cos. C, that is, C A : C B :: rad. : cos. C, otherwise C B : C A :: rad. : sec. C.

to find A B,
we must take C A and A B.



If C A, the hypothenuse, be radius, A B becomes the cosine of A (No. 163).

C A : A B :: rad. : cos. A;

in which A B, a *mean* term, is required. Hence, by No. 166 (1), we have to add the logs. of C A and cos. A, and subtract the log. 10.

C A 28	log. (tab. 64)	1·4472
A 50°	log. cos. (tab. 68)	9·8081
	log.	11·2553
	sub.	10·
A B = 18·0	log.	1·2553

We might have used A B as sin. C, that is, C A : A B :: rad. : sin. C, otherwise A B : A C :: rad. : sec. A.

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* It is necessary to remark here that the process above differs from that followed by seamen in general, the object of which is simply that the required quantity may stand last. The example in Case III. by that method stands thus:

To find the Angles.

As the hypoth A B	2·3430
Is to radius	10·0000
So is the perp. A C	2·0082
	12·0082
	2·3430
To sine of angle B 27° 33′	9·6652
Hence, A is 62° 27′.	

To find the side B C.

As rad.	10·0000
Is to hypoth. A B	2·3430
So is sin. A	9·9478
	12·2908
	10·0000
To B C 195·4	2·2908

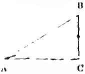
Now the method proposed is more natural than this last; because, when the two sides are taken together, their trigonometrical relation to each other is immediately perceived, which, when they are separated, is not so apparent. Again, since the term sine, or cosine, is determined altogether by that side which we make radius, these terms should, according to the natural progress of ideas, *immediately follow* the term radius. The method followed is also shorter and more elegant. Moreover, the method just quoted, not being employed in

Case II. Given the angles and one leg, to find the hypothenuse and the other leg.

Ex. C is 90°. Angle A is 30° 14′, hence B is 59° 46′. B C is 171. Find A B and A C.

To find A B.

Take the two sides, A B, B C make A B (the hypothenuse) radius; then, No. 163.



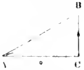
A B : B C :: rad. : sin. A;

in which A B, an *extreme* term, is required. Hence, by No. 166 (2), we have to add the logs. of B C and rad., and subtract the log. of sin. A.*

B C 171	log. + 10, 12·2330
A 30° 14′	log. sine −9·7020
A B = 339·6	log. 2·5310

To find A C.

Take two sides, A C, C B, make A C radius; then, by No. 163 (3).



A C : C B :: rad. : tan. A,

in which A C, an *extreme* term, is required. Hence, by No. 166 (2).

C B 171	log. + 10, 12·2330
A 30° 14′	log. tan. − 9·7655
A C = 293·4	log. 2·4675

This might, like Case I., be worked differently. Thus, to find A B, we may make B C radius; then A B : B C :: rad. : cos. B. Again, to find A C; making B C radius, we have A C : C B :: rad. : tan. B.

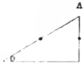
We might also, having found one of the unknown quantities, employ this quantity as a means of finding the rest; but in general it is better, when practicable, to depend only on the original quantities given.

Case III. Given the hypothenuse and one leg, to find the angles and the other leg.

Ex. Angle C is 90°, B A = 220·3, A C = 101·9; find the angle B, and then B C.

To find B.

Taking the two given sides, we have



B A : A C :: rad. : sin. B;

in which sin. B, an *extreme* term, is required.

A C 101·9	log. + 10, 12·0082
B A 220·3	log. −2·3430
B = 27° 33′	sin. 9·6652

Hence A = 62° 27′

To find B C.

Taking the two sides, B C, C A, we have

B C : C A :: rad. : tan B;

in which B C, an *extreme* term, is required.

C A 101·9	log. + 10, 12·0082
B 27° 33′	log. tan. −9·7174
B C = 195·4	log. 2·2908

(Here, in computing by the canons, we are obliged to employ B, as found.)

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any other scientific process, every seaman who may require to extend his scientific knowledge of these subjects will have to unlearn it and to adopt the other. The rules laid down above will be found, after very little practice, simpler and more intelligible, and therefore easier to recollect, than those of the old method.

* Instead of *subtracting* the log. sine, cosine, and tangent, it is the same thing to *add* the log. cosecant, secant, and cotangent, because these last are the arithmetical complements of the first. We have omitted this in the examples, to avoid confusing the learner.

Case IV. Given the two legs, to find the hypothenuse and the angles.

Ex. The angle C (fig. in Case III., only marking B C as given instead of B A) is 90°. B C = 195·4, C A = 101·9: find B A and the angle A.

To find angle A.

A C : B C :: rad. : tan. A.

Hence, by No. 166 (2),

B C 195·4	log + 10, 12·2909
A C 101·9	log. − 2·0082
A = 62° 27′	log. tan 10·2827
and B = 27 33	

To find B A.

Making B C radius, B A will become the secant of B; hence,

B C : B A :: rad. : sec. B.

Hence, by No. 166 (1),

B C 195·4	log. 2·2908
B 27° 33′	log. sec. 10·0523
B A = 220·3	log. 2·3431

As 10 is to be subtracted it is omitted in the index 12.

Ex. 1. The hypothenuse A C is 144, the angle A 39° 22′, whence C is 50° 38′, required A B and B C. Ans. A B is 111·3, and B C 91·3.

Ex. 2. The hypoth. A C 250, the angle C = 35° 30′; find C B and A B. Ans. C B = 203·5, A B = 145·2.

Ex. 3. The perp. B C = 360, the angle A opposite 58° 20′; required the base and hypothenuse A C. Ans. A B = 222, A C = 423

Ex. 4. Given the base A B 208, and angle A 35° 16′; find the hypoth. A C and the perpend. B C. Ans. A C = 254·8, B C = 147·1.

Ex. 5. Given the hypoth. A C 272, and base A B 232, to find the angles A and C, and B C. Ans. A = 31° 28′, C = 58° 32′, B C = 142.

Ex. 6. Given the hypoth. C A 980, and base B C 720, required the angles and remaining leg. Ans. A 47° 17′, C 42° 43′, A B 664·8.

VI. Methods of Solution.*

167. The solution of a question in which the result is required in numbers is obtained in three ways, namely, 1. Inspection; 2. Calculation or Computation; 3. Construction.

(1.) Inspection usually implies taking out, ready calculated, from a table, the result corresponding to the elements of the particular question proposed. The term has, however, a more general acceptation, being applied to the taking out, not merely of the result itself, but of quantities which compose it.

This method being easy and expeditious, is the best for general practice when precision is not required; but as the tables adapted to this kind of solution are necessarily limited, it is, on many occasions, not sufficient.

(2.) The general term Computation may be applied to every mode of solution by the composition of numbers only. Since, however, Inspection includes the simplest cases of this kind, namely, those in which either the required quantity itself, or the parts com-

* The matter in this section is, from its nature, adapted only to the reader who has made some progress in the subject.

The Solution of Oblique-angled Plane Triangles.

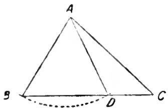
Case I. In any oblique-angled plane triangle, given two sides and an angle opposite to one of them, or two angles and a side opposite to one of them, the remaining angles and sides are found by the following simple proportions :—

As one of the given sides : sin. of its opposite angle
:: the other given side : sin. of its opposite angle.

To find an angle, begin with a side opposite to a known angle.

Again, as sin. of one of the given angles : its opposite side
:: sin. of the other given angle : its opposite side.

To find a side, begin with an angle opposite to a known side.



Ex. 1. In the triangle A B C, given A C B 41° 13′, A C 282 yards, and A B 210 yards, to find the rest.

Now A B 210 being less than A C 282, the case is ambiguous, and there are two solutions.

At point C in the line B C make angle B C A = 41° 13′, from C lay off C A = 282, and from A lay off A B = 210, cutting B C in B and D, join A D.

To find A B C and A D C.

As A B 210	log. 7·677781*
: A C B 41° 13′	log. sin. 9·818825
:: A C 282	log. 2·450249
: A B C 62° 14′	log. sin. 9·946855

A B C = A D B ∴ A D B = 62° 14′ − 180 = A D C 117° 46′

A D C = 117° 46′ + A C B = 41° 13′ = 158° 59′ − 180° = D A C 21° 1′

A C B = 41° 13′ + A B C = 62° 14′ = 103° 27′ − 180° = B A C 76° 33′

To find B C.

As A C B 41° 13′	log. cosec. 0·181175*
: A B 210	log. 2·322219
:: B A C 76° 33′	log. sin. 9·987922
: B C 310′	log. 2·491316

To find D C.

As A C B 41° 13′	log. cosec. 0·181175*
: A B 210	log. 2·322219
:: D A C 21° 1′	log. sin. 9·554658
: D C 114′	log. 2·058052

* See note to p. 49 on the "Arithmetical Complement."

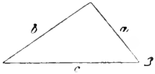
Case II. In any oblique-angled plane triangle, given two sides and the included angle, to find the rest.

As the sum of the given sides : their difference
:: tan. ½ sum of the unknown angles : tan. ½ their difference.

The ½ difference being added to ½ sum will give the greater angle, and being subtracted from it will give the less.

The greater angles will be opposite the greater side.

Ex. 2. In the triangle A B C, given $a = 512$ yards, $c = 907$ yards, and B 49° 10′, to find the rest.



c 907 + a 512 = $c + a$ 1419, c 907 − a 512 = $c - a$ 395,
B 49° 10′ − 180 = A + C 130° 50′ ÷ 2 = $\frac{A+C}{2}$ 65° 25′.

To find A and C.

As $a + c$ 1419		log. 6·848018*
: $a - c$ 395		log. 2·596597
:: $\frac{A+C}{2}$	65°25′	log. tan. 10·339642
: $\frac{A-C}{2}$	31°19′	log. tan. 9·784257

To find b.

As A	34° 6′	log. cosec. 0·251345*
: a	512	log. 2·709270
:: B	49°10′	log. sin. 9·878875
. b	691	log. 2·839490

$\frac{A+C}{2}$ 65° 25′ + $\frac{A-C}{2}$ 31° 19′ = C 96° 44′, and 65° 25′ − 31° 19′ = A 34° 6′.

Case III. In any oblique-angled plane triangle, given the three sides, to find the angles.

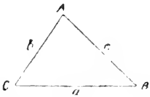
From the half sum of the three given sides (S) subtract the two sides containing a required angle. To the logs. of these numbers add the arithmetical complement of the logs. of the sides; the sum of these 4 logs., rejecting 10 from the index, will be the log. sin. square, Table 69, of the required angle.

Ex. 3. In the triangle A B C, given $a = 6$, $b = 5$, and $c = 4$, to find the rest.

$a + b + c = 6 + 5 + 4 = 15 \div 2 = 7{\cdot}5$(S), S 7·5 − b 5 = 2·5. S 7·5 − 4 = 3·5.

To find A.

S − b	2·5	log. 0·397940
S − c	3·5	log. 0·544068
b	5	Ar. Co. log. 9·301030
c	4	Ar. Co. log. 9·397940
A	82°49′	log. sin. square 9·640978



* See note to p. 19 on the "Arithmetical Complement."

posing it, are taken from tables, the term Computation will be employed in other cases, and always when precision is required and logarithms are concerned.*

(3.) Construction implies (in our present subject) drawing a figure of the actual case on a convenient scale, and in the proper proportions, the number of parts contained in the quantity required to be measured being taken from a scale adapted to the purpose.

This process is tedious, and not, in general, capable of much precision, but it is the most readily intelligible of the three methods, and is, therefore, the least open to mistake. The seaman should, accordingly, be able to produce a figure of every case that admits one, and should acquire the habit of referring to the figure, in the mind as the only real security against mistakes in his work.

The figure or natural representation of the case is, moreover, the foundation of the mathematical treatment of the question.

1. *Limits of Methods or Observations.*

168. In every process of calculation, the elements which enter into it, and which are either observed at the time by instruments, or taken from tables, are liable to error. Every result, therefore, is, to some extent, uncertain; but the *amount* of error of the final result

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* Solutions of this kind are usually divided into "rigorous" and "approximate," or Indirect, as the latter are also called. In all solutions, however, we either deal directly with the quantities themselves, as arcs, angles, &c., in their entire or *integral* state, or we compute a *difference* from a certain value assumed or given, and thence find the required quantity. This last process is indirect, but the former may be effected indirectly also. The terms Integral and Differential would then, it is presumed, be more satisfactory, for the degree of approximation obtained is altogether beside the question of the character of the solution. We do not, however, on the present occasion, depart from the usual terms. We shall merely add, as some indistinctness prevails as to the properties of these different solutions, that both are equally affected by errors of observation (as must of course follow, if they be both true), and thus the essential distinction between them, in practice, lies in the different numbers of figures which they respectively require.

There is another point on which we shall take the opportunity to make some remarks for the satisfaction of the scientific reader. In the present subject we are obliged, in most cases, to consider the required quantity, though really unknown, as if it were given, as it is an indispensable argument in reducing the elements;—thus, in finding the longitude by chronometer, by the sun, we must assume a longitude in order to deduce the declination and equation of time. Such solutions are, therefore, *solutions by assumption*, and the question naturally arises, What is the criterion by which to know whether the result is nearer the truth or further from it than the temporary value employed?

In general we have to solve, not the equation $u = f(x, y, z)$, but $u_1 = f(x, y, z, u')$, in which u' is an assumed value of u, and u_1 a first approximation. The second approximation is $u_2 = f(x, y, z, u_1)$, and so on. Now, it is evident, without examining the successive differences $u' - u_1$, $u_1 - u_2$ .... that the process is convergent, if u varies more slowly than u', that is, when $\frac{du}{du'} < 1$. This is the case with all our problems within the limits assigned. When $\frac{du}{du'} > 1$, the process is divergent, or the results are worse and worse; and when $= 1$, the assumption is reproduced. Again, when $\frac{du}{du'}$ is positive, the results are all greater or all less than the truth; when negative, they are alternately too great, and too small. Hence, in general, it depends on the *data*, and not on the greatness or smallness of the error of assumption, whether the process converge or not. The above, however, applies, in strictness, only to small errors of assumption, for large errors higher terms must be considered.

caused by an error in any one of the *data* (or quantities given for the solution of the question) is very different under different circumstances, being in some cases scarcely perceptible, while in others it may far exceed the very error to which it is due.

If we agree beforehand that a probable error of observation shall not cause an error beyond a certain amount in the result, we must exclude all those cases in which it would produce a greater effect, and we thus assign *limits* to the method or observation.

169. Generally speaking, every element that enters into the computation is liable to error, and, therefore, each element will have its own independent influence in limiting the observation; that is, in strictness, there will be *different limits* for each separate element, but, for practical purposes, it is enough to assign the limits according to that element of which the error is most important. For instance, in finding the time by a single altitude of a celestial body, we employ its altitude and declination, and the latitude of the place. Now the latitude will often, and the declination sometimes, be correctly known, but the altitude can never, from various causes, be exempt from suspicion of inaccuracy; besides, in general, an error of altitude produces a greater effect on the result than an equal error in latitude or declination. Hence we limit the method of "time by an altitude off the meridian" in respect of altitude only; and assuming that 1′ error of altitude shall not cause more than 10^s error in the time, we limit, for the more frequented latitudes, the celestial body to a certain bearing.

2. *Degree of Dependance.*

170. The result of every computation is, as above remarked, No. 168, more or less uncertain. If we knew the error in one of the elements, we could easily find the effect it would produce on the result, by working the computation over again; and if, under the circumstances, such error in the data is not likely to exceed a certain quantity, we should thus find the *limit of probable error*;* for example, suppose in finding the time, the error of altitude is not likely to exceed 2′, and that the effect of this in working over again is 9^s, we say that 9^s is the limit of probable error.

171. Since all the elements are more or less uncertain, there is a limit of probable error or degree of dependance in respect of each. Hence the extreme probable error of the result is the sum of all these errors, supposing they lie on the same side. But, in practice, they will, in general, tend to neutralise each other, and it is enough to estimate the degree of dependance in respect of the most important of them.

172. In some cases a small error of observation will produce a very great error in the result; in others, a large error may not pro-

* The term "Degree of Dependance" is preferred here to "limit of probable error," because it describes in direct terms the application or use of that limit, which is, to point out how near the result may be depended upon.

duce a sensible effect. For example, an error of 1′ in the lunar distance, causes an error of 30′ or 40′ in the longitude, while an error of several miles of latitude may not, in certain cases, produce an error worth notice in the time as found by an observation. As no nicety in the mere working of the computation can, in any way, meet or counteract errors of observation, it is necessary, in forming a true judgment of the place of the ship, to try the effects of probable errors; in other words, to try the degree of dependance. Thus, in the example of the lunar alluded to above, a novice might conclude that his longitude was, to the exact minute and second, that found by computation; but a more experienced computer, knowing that all his elements are not absolutely correct, and that his result can scarcely be perfectly exact but by an accidental compensation of errors, makes an allowance for error; and assuming that the distance may be too much or too little by 30″, for example, considers the observation as merely having established with certainty the ship's place within 15′E. or W. of the position deduced.

173. But the degree of dependance, besides being indispensable to rightly judging of the true place of the ship, or, rather, of the space on latitude and longitude within which she is to be found, has another important application, as it governs the amount of labour bestowed on the computations. For example, if the latitude is uncertain several miles, it is at once evident, that to proceed with as much care and precision as if it were ascertained to a few seconds, is mere waste of time. Similar remarks have already been offered in the Preface, and they are particularly directed to the student's attention, who should be early impressed with the importance of improving his judgment by continual exercise, instead of trusting on all occasions to a mechanical routine of computation.

174. It is worth while to notice, that in working to a certain degree of accuracy, as, for example, to minutes, it is generally enough to employ the nearest whole minute; but when one of the quantities varies very rapidly, it may be proper to work closer; for it is easy to see that the inaccuracy of half a minute in a quantity which is multiplied by a number greater than 1, is increased, and appears as a whole minute.

[1.] *Personal Error.*

175. The several errors to which each observation is exposed, and which accordingly enter into the estimation of the degree of dependance, are described in their proper places; but there is one which, though sensible only in cases where a considerable step has been made towards precision, is of universal application, and is, therefore, properly noticed here.

It is found that different persons do not agree in the precise instant of observing the same phenomenon. Again, some persons are in the habit of observing more or less closely than others. The kind of error which is obviously present in such cases, is called the *personal error*, or *equation*.

Two observers have been found to differ $0^s{\cdot}4$ in the sun's transit over the wire of a telescope.

176. When two images, in contact, lie stationary before two observers, it is difficult to understand why one of them should see them overlap, or the other open, or why they should not agree in the measure. But when the images are in motion, the observer's anxiety is roused lest he may miss the observation, and the excitement may lead him to think that he sees the contact before it really takes place. Hence there is reason to believe that the personal equation is, in some degree, a matter of temperament.

It also seems well ascertained that the personal equation is not the same for the same individual at all times, and that it is greatly influenced by fatigue, by the effort of observing, and, in fact, by every cause that affects the nervous system. It may, therefore, be advantageous to bear these circumstances in mind preparatory to undertaking observations in which much accuracy is required.

177. The existence of this error shews that when much precision is required, observations taken by different persons should not be mixed together until cleared of personal errors, since they may at the outset be presumed to be affected by unequal errors; and it is probable that many discrepancies are due to this cause, in observations whether by the same or different observers.

Spherics, Definitions and Principles

Spherics is that part of mathematics which treats of the positions and magnitudes of arcs of circles described on the surface of a sphere.

A Sphere is a solid formed by the revolution of a semicircle about its diameter; this diameter is immovable during the motion of the semicircle.

The Centre and Axis of a sphere are the same as the centre and diameter of the generating semicircle, and as a circle has an indefinite number of diameters, so a sphere may be considered to have an indefinite number of axes, round any one of which it may be conceived to be generated.

Every Section of a Sphere made by a plane passing through its circumference is a circle.

A Great Circle is formed by a plane passing through the centre of the sphere. A Small Circle is formed by a plane that does not pass through the centre of the sphere. A sphere is therefore divided into two equal parts by the plane of every great circle, and into two unequal parts by the plane of every small circle.

The Poles of a Circle of a sphere are those points on the surface of the sphere which are equally distant from the circumference of that circle. Thus the poles of a circle are the extremities of that diameter or axis of the sphere which is perpendicular to the plane of that circle. All points in the circumference of a great circle are equally distant from *both* its poles.

Small Circles of the sphere are those circles which are unequally distant from both their poles.

The Poles of every great circle are each 90° distant from that great circle on the surface of the sphere, and no two great circles can have the same poles.

The Diameter of every great circle passes through the centre of the sphere, but the diameters of small circles do not pass through the centre. Thus the centre of the sphere is the common centre of all its great circles.

Parallel Circles of a sphere are those small circles the planes of which are parallel to the plane of some great circle. All parallel circles have the same poles, and may be conceived to be concentric to the great circle they are parallel to.

A Spherical Angle is the inclination of two great circles of the sphere meeting one another. It is measured by an arc of a great circle intercepted between the legs of that angle, 90° distant from the angular point.

A Spherical Triangle is a figure formed on the surface of the sphere by the intersection of three great circles.

The Shortest Distance between two points on the surface of a sphere is an arc of the great circle passing through those points.

The Stereographic Projection * of the sphere is such a representation of its circles upon the plane of some great circle, and thence called the plane of projection, as would appear to an eye placed in one of the poles of that circle, and thence viewing the circles of the sphere.

The place of the eye is called the projecting point or lower pole, and the pole opposite is called the opposite or exterior pole; also the projection of any point on the sphere is that point in the plane of projection through which the visual ray passes to the eye.

The Primitive Circle is that great circle on the plane of which the representation of all other circles is supposed to be drawn.

A Right Circle is one which is perpendicular to the plane of the primitive circle, and, if it be a great circle, its plane passes through the eye and it is seen edgewise, consequently it is represented by a straight line drawn through the centre of the primitive circle.

An Oblique Circle is that which has its plane oblique to the eye, and is represented by a curved line.

Spherical Trigonometry is the art of computing the measures of the sides and angles of such triangles as are formed on the surface of a sphere, by the mutual intersection of three great circles described thereon.

A Spherical Triangle has three sides and three angles.

A Right-angled Spherical Triangle has one right angle. The sides about the right angle are called legs; the side opposite the right angle is called the hypothenuse.

A Quadrantal Spherical Triangle has one side equal to 90°.

An Oblique Spherical Triangle has all its angles oblique.

The Circular Parts of a triangle are those arcs which measure its sides and angles.

Two spherical triangles are said to be *supplemental* to one another when the sides and angles of the one are supplemental of the sides and angles of the other, and one in regard to the other is called the supplemental triangle.

Two arcs or angles when compared together are said to be *alike* when both are less or greater than 90°. But when one is greater and the other less than 90°, they are said to be *unlike*.

In every spherical triangle equal angles are opposite equal sides, and equal sides are opposite equal angles.

* Stereographic means representing a solid on a plane surface.

Any two sides of a spherical triangle are together greater than the third side.

Each side of a spherical triangle is less than a semicircle or 180°.

In every spherical triangle the greater side is opposite the greater angle. The sum of the three sides of a spherical triangle is less than 360°.

The sum of the three angles of a spherical triangle is greater than two right angles and less than six, or always will fall between 180° and 540°.

In right-angled spherical triangles, the oblique angles and their opposite sides are of *like affection*; that is, if a leg is less or greater than 90°, its opposite angle is also less or greater than 90°.

In right-angled spherical triangles the hypothenuse is *less than* 90° when the legs are of a *like kind*; but *greater than* 90° when the legs are of a *different kind*.

In any spherical triangle

As sine of either angle : sine of its opposite side
:: sine of another angle : sine of its opposite side.

Right Spherics.

The celebrated Lord Napier, inventor of logarithms, contrived a general rule, easy to be remembered, by which the solution of every case of right-angled spherical triangles is readily obtained.

In any right-angled spherical triangle there are five parts beside the right angle—viz., two legs, two angles, and the hypothenuse. The two legs, the complements of the two angles, and the complement of the hypothenuse are called circular parts.

In any case relating to right-angled spherical triangles three of these circular parts are concerned—viz., two given and one sought.

If the three concerned are all joined together, ignoring the right angle, the central one is called the middle, and the other two adjacent parts.

But if only two are joined together these are called the opposite, and the other the middle part.

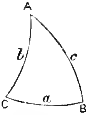
These being known, all the cases of right-angled spherical triangles may be solved by Napier's rules.

1. The product of radius and sine of the middle part = the product of the tangents of the adjacent parts.

2. The product of radius and sine of the middle part = the product of the cosines of the opposite parts.

N.B.—As an aid to memory the letter *a* occurs in *tangent* and *adjacent*; and the letter *o* in *cosine* and *opposite*. In the following examples, instead of *subtracting* the log. sine, cosine, and tangent, it is the same thing to *add* the log. cosec., sec., and cot.; because these last are the arithmetical complements of the first (*see* note, p. 49).

Ex. 1. In the right-angled spherical triangle A B C, given C 61° 50′, B C (a) 40° 30′, B 90°, to find the other parts.



To find A.

Rad. cos. A = sin. C . cos. a
cos. A = sin. C . cos. a

C = 61° 50′	log. sin. 9·945261
a = 40 30	log. cos. 9·881046
A = 47 54	log. cos. 9·826307

To find A C (b).

Rad. cos. C . = cot. b . tan. a
cot. b = cos. C . cot. a

a = 40° 30′	log. cot. 0·068501
C = 61 50	log. cos. 9·673977
b = 61 4	log. cot. 9·742478

To find A B (c).

Rad. cos. b = cos. a . cos. c
cos. c = sec. a . cos. b

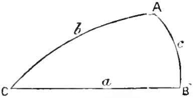
a = 40° 30′	log. sec. 0·118955
b = 61 4	log. cos. 9·684658
c = 50 29	log. cos. 9·803613

Ex. 2. In the right-angled spherical triangle A B C, given A B (c) 50° 40′, A C (b) 113° 26′, B 90°, to find the other parts.

To find C.

Rad. sin c = sin. b . sin. C
sin. C = sin. c . cosec. b

b = 113° 26′	log. cosec. 0·037383
c = 50 40	log. sin. 9·888444
C = 57 28	log. sin. 9·925827



To find B C (a).

Rad. cos. b = cos. c . cos. a
cos. a = cos. b sec. c

c = 50° 40′	log. sec. 0·198027
b = 113 26	log. cos. 9·599536
51 8	log. cos. 9·797563
180 0	
a = 128 52	

To find A.

Rad. cos. A = tan. c . cot. b
cos A = tan. c . cot. b

c = 50° 40′	log. tan. 0·086471
b = 113 26	log. cot. 9·636918
58 4	log. cos. 9·723389
180 00	
A = 121 56	

NOTE.—In the triangle A B C, b the hypothenuse being greater than 90°, and c less than 90°, A is of unlike affection to C, or greater than 90°. Also A being greater than 90° its opposite side a must also be greater than 90°.

Quadrantal spherical triangles are also solved by Napier's rules reversed: using the quadrantal side as the right angle, the angles adjacent to it, the complements of the other two sides, and of the angle opposite to the quadrantal side, as circular parts.

OBLIQUE SPHERICS.

Case I. Given two sides and an angle opposite to one of them, to find the angle opposite to the known side.

As sin. of a given side : sin. of its opposite angle
:: sin. of the other given side : sin. of its opposite angle.

To find the 3rd side.

As sin. $\frac{1}{2}$ diff. of the two known angles
: sin. $\frac{1}{2}$ their sum
:: tan. $\frac{1}{2}$ diff. of the two known sides
: tan. $\frac{1}{2}$ the third side.

Or, as cos. $\frac{1}{2}$ diff. of the two known angles
: cos. $\frac{1}{2}$ their sum
:: tan. $\frac{1}{2}$ sum of the two known sides
: tan. $\frac{1}{2}$ the third side.

Case II Given two angles and a side opposite to one of them, to find the side opposite to the known angle.

As sin. of a given angle : sin. of its opposite side
:: sin. of the other given angle : sin. of its opposite side.

To find the 3rd angle.

As sin. $\frac{1}{2}$ diff. of the two known sides	Or, as cos $\frac{1}{2}$ diff. of the two known sides
: sin $\frac{1}{2}$ their sum	: cos. $\frac{1}{2}$ their sum
:: tan. $\frac{1}{2}$ diff. of the two known angles	:: tan. $\frac{1}{2}$ sum of the two known angles
: cot. $\frac{1}{2}$ the third angle.	: cot. $\frac{1}{2}$ the third angle.

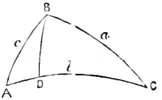
Cases I. and II. may also be solved by drawing a great circle from the unknown angle perpendicular to the opposite side. This divides the triangle into two right-angled triangles. The segments of the divided side may then be found by right-angled spherics.

In the spherical triangle A B C, given A 84° 52′, BC or (a) 67° 5′, and A B or (c) 55° 38′.

To find the other parts.

As sin. a : sin. A :: sin. c : sin. C.

a = 67° 5′	log. cosec.	0·035706
A = 84 52	log. sin.	9·998255
c = 55 38	log. sin.	9·916687
C = 63 12	log. sin.	9·950648



From B draw a great circle B D perpendicular to A C. Angles A and C being of like affection, both less than 90°, B D falls within the triangle. Then by Napier's rules:

To find A C (b).

Rad. cos. C = cot. a . tan. D C
tan. D C = cos. C . tan. a

a = 67° 5′	log. tan.	0·373907
C = 63 12	log. cos.	9·654059
D C = 46 51	log. tan.	10·027966
A D = 7 27		
b = 54 18		

Rad. cos. A = cot. c . tan. A D
tan. A D = cos. A tan. c

c = 55° 38′	log. tan.	0·165031
A = 84 52	log. cos.	8·951698
A D = 7 27	log. tan.	9·116729

To find B.

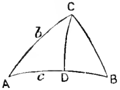
As sin. a : sin. A :: sin. b : sin. B.

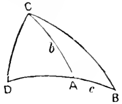
a = 67° 5′	log. cosec.	0·035706
A = 84 52	log. sin.	9·998255
b = 54 18	log. sin.	9·909601
B = 61 25	log. sin.	9·943562

If A and C are of unlike affection—*i.e.* one greater and one less than 90°—the perpendicular will fall without the triangle, and the difference between A D and D C must be taken to find b.

This also will solve Case II., given two angles and a side opposite to one of them, to find the other parts

Case III. Given two sides and the included angle.





Let A B, A C and the included angle A be given. From one of the unknown angles at C draw a great circle perpendicular to the opposite side. Then in the right-angled triangle A D C find A D. If the perpendicular falls within the triangle subtract A D from A B to find D B, and if the perpendicular falls without the triangle add A D to A B, and the sum is B D.

To find B C.

As cos. of A D : cos. of B D :: cos of A C : cos of B C.

To find the unknown angles.

As sin. of side just found : sin. of the given angle
:: sin. of either of the given sides : sin. of its opposite angle.

Second Method.

To find $\frac{1}{2}$ sum of the unknown angles.

As cos. $\frac{1}{2}$ sum of the two given sides : cos. $\frac{1}{2}$ their diff.
:: cot. $\frac{1}{2}$ the included angle : tan. $\frac{1}{2}$ sum of unknown angles.

NOTE.—This $\frac{1}{2}$ sum of the unknown angles is of the same name as the $\frac{1}{2}$ sum of the sides.

To find $\frac{1}{2}$ diff. of the unknown angles.

As sin. $\frac{1}{2}$ sum of the two given sides : sin. $\frac{1}{2}$ their diff.
:: cot. $\frac{1}{2}$ the included angle : tan. $\frac{1}{2}$ diff. of the unknown angles.

The $\frac{1}{2}$ diff. being added to the $\frac{1}{2}$ sum will be the greater angle, and being subtracted from it will be the less.

In the spherical triangle A B C, given B 125° 36′, B C (a) 81° 17′, and, A B (c) 59° 13′, to find the other parts:

$c = 59° 13'$	$a = 81° 17'$	$B = 125\ 36$
$a = 81\ 17$	$c = 59\ 13$	$62\ 48\ \frac{B}{2}$
$140\ 30\ a+c$	$22\ 4\ a-c$	
$70\ 15\ \frac{a+c}{2}$	$11\ 2\ \frac{a-c}{2}$	

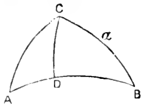
To find angles C and A.

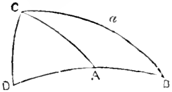
$\frac{a+c}{2} = 70° 15'$	log. sec. 0·471190	$\frac{a+c}{2} = 70° 15'$	log. cosec. 0·026329
$\frac{a-c}{2} = 11\ 2$	log. cos. 9·991897	$\frac{a-c}{2} = 11\ 2$	log. sin. 9·281897
$\frac{B}{2} = 62\ 48$	log. cot. 9·710904	$\frac{B}{2} = 62\ 48$	log. cot. 9·710904
$\frac{A+C}{2} = 56\ 11$	log. tan. 10·173991	$\frac{A-C}{2} = 5\ 58$	log. tan. 9·019.30
$\frac{A-C}{2} = 5\ 58$		$\frac{A+C}{2} = 56\ 11$	
$50\ 13$ C		$62\ 9$ A	

To find side b.

C = 50° 13′	log. cosec. 0 114373
c = 59 13	log. sin. 9·934048
B = 125 36	log. sin. 9 910144
b = 114 38	log. sin. 9 958[illegible]

Case IV. Given two angles and the included side.





In the triangle A B C given angles B, C, and side B C, a : to find the other parts. Where two angles and an included side are given, a great circle may be drawn from one of the given angles perpendicular to the opposite side, and the angle B C D instead of the segment B D found. The difference between B C D and the given angle C will give A C D. Then

To find the 3rd angle.

As sin. B C D : sin. A C D :: cos. B : cos. A.

If the perpendicular falls within the triangle the angles B and A are of the same name; if it falls without the triangle they are of different names.

The Second Method is the same as in Case III., only for *cots.* of half included angle use *tans.* of half included side.

Case V. Given the three sides of a spherical triangle, to find the three angles.

Find the half-sum of the three sides. Take the difference between this half-sum and the side opposite to a required angle, then add together the log. cosecs. of the two sides containing the angle, the log. sines of the half-sum, and of the difference between the half-sum and the side opposite the required angle: Half the sum of these four logs will be the log. cos. of half the required angle.

In the spherical triangle A B C, given A B (c) 79° 56′, B C (a) 119° 36′, and A C (b) 64° 5′, to find angle B.

a = 119°	36′		log. cosec.	·060733	
c = 79	56		log. cosec.	·006738	
b = 64	5				
2) 263	37				
131	48	30	log. sin.	9·872377	
67	43	30	log. sin.	9·966318	log. sin. square of
			2)	19·906166	127° 41′ 20″, supplement B.
$\frac{B}{2}$ = 26	9	20	log. cos.	9·953083	
		2			
B = 52	18	40			

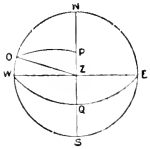
Case VI. The three angles being known, to find a side.

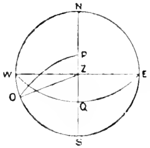
Add together the log. cosecs. of the two angles adjacent to the required side and the log. cosines of the half-sum of the three angles and the difference between the half-sum and the angle opposite the required side. Half-sum of these four logs. will be the log. sine of half the required side.

Application of the Preceding Cases in Spherical Trigonometry to Questions in Nautical Astronomy.

The Amplitude.

In these figures N E S W represents the horizon, S and N being its south and north points; N Z S the celestial meridian; O the place of the body observed on the horizon, O W the amplitude, P the pole of the heavens, P O the polar distance, less or greater than 90°, as the declination of the body observed is of the same or of a different name to the latitude; Z the zenith. W E the prime vertical, and W Q E the equator.





From Right Spherics, p. 57A.

In the problem to find the amplitude of a heavenly body, No. 884, there are given P N the lat. and P O the polar distance to find O W the amplitude.

Then in right-angled triangle P O N

$$\text{Rad.} \times \cos. \text{P O} = \cos. \text{P N} \cos. \text{O N}$$

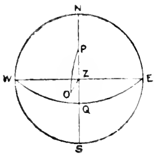
$$\cos. \text{O N} = \cos. \text{P O} \sec. \text{P N, or}$$

$$\text{Log. sec. P N (lat.)} + \text{log. sin.} \begin{Bmatrix} 90° - \text{P O} \\ \text{P O} - 90° \end{Bmatrix} \text{(dec.)} = \text{log. sin.} \begin{Bmatrix} 90° - \text{O N} \\ \text{O N} - 90° \end{Bmatrix};$$

i.e. O W the amplitude.

The question can also be solved by the quadrantal triangle Z P O, where P Z O, and therefrom O W, may be found.

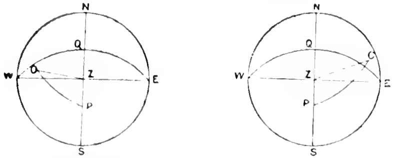
Latitude from Reduction to the Meridian.



From Oblique Spherics, Case I., p. 58A.

Given Z P O the hour angle, P O the polar distance, and Z O the zenith distance, or two sides and an angle opposite to one of them, to find the remaining side P Z, or the colat. at the time of observation, *see* Nos. 700 to 704 and explanation of Table 70, page 427.

THE HOUR ANGLE AND AZIMUTH.

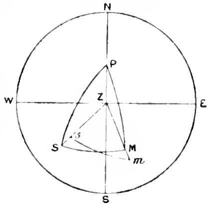


From Oblique Spherics, Case V., p. 61A.

Here are given: P Z the colat., P O the polar distance, and Z O the zenith distance, or the three sides of the triangle Z O P; to find either Z P O the hour angle, or P Z O the azimuth, *see* Nos. 614 and 674.

LUNARS.

From Oblique Spherics, Cases V. and III., pp. 61A and 60A.



The Lunar problem is fully treated upon (*see* Nos. 836 to 863). The figures of 837 show the solution by oblique spherics, where first, in the triangle *s* Z *m*, three sides, the two apparent altitudes Z *m* and Z *s*, and the apparent distance *m s* are given, to find angle *m* Z *s*; and then in the triangle M Z S, two sides, the two true altitudes Z M and Z S and the included angle Z are given, to find the true distance M S.

DOUBLE ALTITUDE.

From Oblique Spherics, Cases III. and V., pp. 60A and 61A.

For two altitudes of the same body the solution of this problem is fully given at No 757, and figure at p 268, where right spherics are used: *see* p. 57A. If different bodies are used, the problem is solved by oblique spherics.

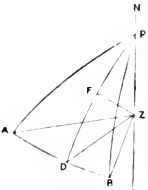


Fig. 1.

Fig. 1 illustrates a double altitude where the observations are taken of the same body and right spherics are used. In this case, A and B are the places of the body in the two observations; P A, P B, the polar distances;

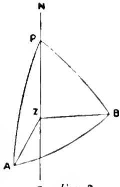


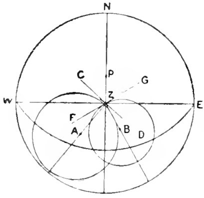
Fig. 2.

Z A, Z B the zenith distances; A P B the polar angle or interval. P D is drawn perpendicular to A B, dividing A P B into two equal parts; Z F is drawn perpendicular to P D.

Fig. 2 illustrates the problem where observations of two different bodies are taken, and the problem solved by oblique spherics. *See* No. 770, Note to pages 273, 274, and figure at page 268.

Sumner's Method.

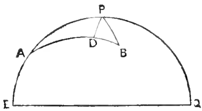
From two altitudes of the same heavenly body taken at a requisite interval apart, or two altitudes of different stars (having the requisite interval in azimuth) taken at the same time, two small circles (circles of position) may be described, the intersection of which * will be the place of the ship, allowing for her run in the interval.

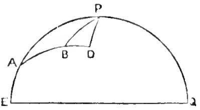


In the figure A and B represent the places of the body or bodies at the time or times of observation. From these points as centres, with the zenith distances, small circles are drawn, the intersection of which will be the zenith of the observer, or place of the ship.

The intersection of these circles will be represented on the chart by the two straight lines C D and F G, drawn at right angles to Z A and Z B, the bearings of the body or bodies at the time of observation. Full explanation of this useful method, with an illustrative chart, will be found under Nos. 1009 to 1014.

Great Circle Sailing.





From Oblique Spherics, Case III., p. 60A.

Given P A and P B the two colats. and A P B the diff. long., to find A B the distance and A and B the courses from one place to the other; or given two sides P A and P B, and included angle A P B, to find the other parts.

The position of the vertex D will be found from the right-angled triangles A P D or B P D. This problem is fully treated upon in Nos. 336 to 347.

* A chartlet showing this intersection will be found in Lecky's Wrinkles, 9th edit p. 502.

NAVIGATION.

CHAPTER I.

Definitions.

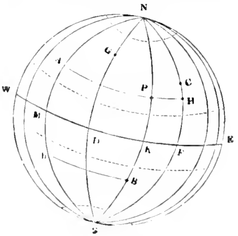
178. By the general term Navigation is meant that science which relates to the determination of the place of a ship on the sea.

179. The place of a ship is determined by either of two methods, which are independent of each other: 1st, by referring it to some other place, as a fixed point of land, or a former place of the ship herself; 2d, by astronomical observation.

The first of these methods is treated under the head of Navigation; the second, under that of Nautical Astronomy.

180. The earth is nearly a globe or sphere: this is proved in three ways. 1st. When a vessel is seen at a considerable distance on the sea, in any part of the world, the hull is partly or entirely concealed by the water, though the masts are visible. 2d. The shadow of the earth thrown on the moon when the earth is between the sun and the moon is, in all positions of the earth, circular. 3d. The earth has been sailed round.

The earth, however, is not exactly spherical, but of the figure called an oblate spheroid, which resembles an orange, the shortest diameter (that which joins the poles) being 7899 statute miles, and that of the fullest parts (about the equator) being nearly 26 more.



181. The earth turns once round in 24 hours. The line round which it revolves, and which is the shortest diameter, is called the *axis*, and its extremities are the North and South Poles, as N, S.

182. The EQUATOR, called also the Equinoctial Line, or vulgarly the Line, is a circle equidistant from both poles, as W M E, and dividing the globe into two half globes, or hemispheres, N W E and S W E.

At all places on this circle the sun rises at 6 A.M., and sets at 6 P.M., all the year round; the days and nights are thus equal, being 12 hours each.

183. A MERIDIAN is a semicircle joining the two poles, as N A S, N B S. Every portion of the meridian lies north and south, and places lying north and south of each other are said to be on the same meridian.

184. LATITUDE is the distance from the equator, measured on a meridian; thus the latitude of a place A is A M, the latitude of B is B K.

Latitude is named north or south, according as the place is north or south of the equator. Thus A is in north latitude, B is in south latitude.

185. The COLATITUDE is the complement of the latitude to 90°; thus N A, S B, N C, are the colatitudes of the places A, B, C.

The colatitude reckoned from the other pole is the sum of the latitude and 90°; thus the colatitude of A is also S A, which is 90° + M A (the latitude of A): N B is the colatitude of B.

186. Latitude is measured in degrees, minutes, and seconds. A minute, or *nautical mile*, contains about 6082 feet, or 1013 fathoms, and therefore, a second is about 101 feet, or 17 fathoms nearly. *See* p. 104, note, and Spheroidal Tables, p. 724.

187. Circles parallel to the equator, that is, equidistant from it in every point, are *parallels of latitude*; as A P H, b B. Two places in the same latitude are said to lie on the same parallel.

188. The DIFFERENCE OF LATITUDE of two places is the portion of the meridian included between their parallels. Thus, A b is the difference of latitude of the two places A, B; C H is that between A and C.

The difference of latitude of the ship is, therefore, the distance she makes good in a north and south direction.

Difference of latitude is also called *Northing* and *Southing*, and is marked N. or S. It is then said to be one of these *names*.

189. It is evident, that when two places are on the *same* side of the equator, their diff. lat. is found by subtracting the lesser latitude from the greater; and that when they are on *opposite* sides of the equator, that is, when one place is in north latitude, and the other in south latitude, the *sum* of their latitudes is their diff. lat. Thus the diff. lat. of A and B, which is A b, is the sum of the north latitude A M, and the south latitude B K, or M b.

Ex. 1. Find the diff. lat. of Cape Clear and Cape Finisterre.

Cape Clear.........	51°	26′	N.
Cape Finisterre ..	42	54	N.
DIFF. LAT.	8	32	

Ex. 2. Find the diff. lat. of Cape Verd and Cape St. Roque.

Cape Verd	14°	43′	N.
Cape St. Roque	5	28	S.
DIFF. LAT.	20	11	

Ex. 3. A ship sails from lat. 50° 19′ N. to 48 12′ N.: find her diff. lat.

Lat. left	50° 19′ N.	
Lat. in	48 12 N.	
DIFF. LAT.	2 7	or 127 miles.

Ex. 4. A ship sails from lat. 1° 11′ N. to 0° 13′ S.: find her diff. lat.

Lat. left	1° 11′ N.	
Lat. in	0 13 S.	
DIFF. LAT.	1 24	or 84 miles.

Examples for Exercise.

Required the diff. lat. between the following places:

1. Between a place A in lat. 42° 21′ N., and another place B in lat. 37° 32′ N. Ans. 289 miles.
2. Between Halifax and the Cape of Good Hope. Ans 4716 miles.
3. Between Diego Ramirez and Cape Lopatka. Ans. 6447 miles.

190. When a ship in north latitude sails north she evidently increases her latitude; and so, likewise, when in south latitude she sails south; because, in these cases, she increases her distance from the equator, at which the latitude begins.

But if in north latitude she sails south, or in south latitude she sails north, she diminishes her latitude.

Hence, when one latitude and the diff. lat. are given, the other latitude is easily found.

Ex. 1. A ship from 43° 30′ S. sails 219 miles south: required her lat. in.

Lat. left	43° 30′ S.
Diff. lat. 219′	3 39 S.
LAT. IN	47 9 S.

Ex. 2. A ship from lat. 43° 11′ N. makes 194 miles southing: required her lat. in.

Lat. left	43° 11′ N.
Diff. lat. 194′ ...	3 14 S.
LAT. IN	39 57 N.

Ex. 3. A ship from lat. 1° 3′ N. sails 123 miles south: required her lat. in.

Lat. left	1° 3′ N.
Diff. lat. 123′......	2 3 S.
LAT. IN	1 0 S.

The ship being in 1° 3′, or 63 miles N. of the equator, must evidently be in S. lat. after making 123 miles southing. Thus, in subtracting one of the quantities from the other, the difference takes the *name* of the greater.

Examples for Exercise.

1. A ship from lat 59° 27′ S. sails southward until her diff. lat. is 374: find her present lat. Ans. 65 41′ S.
2. Lat. left 48° 2′ S diff. lat. 149 N.; what is the lat. in? Ans. 45° 33′ S.
3. Lat. left 53 4′ N. diff. lat. 122′ N.; find the lat. in. Ans. 55° 6′ N.
4. Lat. left 0° 0′, diff. lat. 2° 13′ S.; what is the lat. in? Ans. 2° 13′ S

191. LONGITUDE is the distance measured on the equator between the meridian of a given place and another meridian, called the *first meridian*.* The first meridian with us is the meridian of Greenwich Observatory; thus, if G be Greenwich (fig. in No. 180), the longitude of A is D M, the longitude of B is D K.

The longitude of a place is named East or West, according as it is to the east or west of the first meridian; thus A is in west longitude, H is in east longitude.

* The first meridian is a matter of arbitrary choice amongst different nations; thus, the French refer to Paris. It is therefore necessary, in taking up a chart, to observe what meridian the longitude is reckoned from. See p. 395.

192. We may use either the longitude of one name or the supplement to 360°, with the contrary name; thus, instead of 166° W. we may say 194° E.

193. Longitude is measured either in *space* (or arc), that is, in degrees, minutes, and seconds; or in *time*, that is, in hours, minutes, and seconds, each hour being equal to 15 degrees; for the sun, which regulates the time, returns to the same meridian again, after describing a complete circle, or 360°, in 24 hours, and 15 × 24 is 360.

194. The DIFFERENCE OF LONGITUDE of two places is the portion of the equator included between their meridians; thus M F is the diff. long. of A and C, as also of A and H, and of b and C. To measure, therefore, the diff. long. of two places, we must follow down their meridians to the equator, and then take the included portion of the equator itself.*

195. When two places are on the *same* side of the first meridian, their diff. long. is found by *subtracting* the lesser longitude from the greater; thus the diff. long. of C and P, that is, the difference between D F and D K, is K F. But where the places are on *opposite* sides of the first meridian, that is, when one place is in east longitude and the other in west longitude, the *sum* of their longitudes is the diff. long.; thus the diff. long. of A and P, as also of A and B, is M K, which is the sum of M D and K D.

When one longitude being east and the other west, the sum exceeds 180°, take the supplement to 360° for the diff. long.

Ex. 1. Find the diff. long. of Ushant and the east point of Madeira.

Ushant	5° 3′	W.
E. point of Madeira	16 39	W.
DIFF. LONG.	11 36	

Ex. 2. Find the diff. long. of the Cape of Good Hope and Tristan d'Acunha.

Cape of Good Hope	18° 29′	E.
Tristan d'Acunha	12 2	W.
DIFF. LONG.	30 31	

Ex. 3. A ship sails from longitude 7° 56 W. to 18° 32′ W.: find her diff. long.

Long. left	7° 56′	W.
Long. in	18 32	W.
DIFF. LONG.	10 36	

Ex. 4. A ship sails from longitude 1° 20 W. to 2° 17′ E.: find her diff. long.

Long. left	1° 20′	W.
Long. in	2 17	E.
DIFF. LONG.	3 37	

Examples for Exercise.

Required the difference of longitude between the following places:

1. Between Halifax and the Cape of Good Hope. Ans. 4924′.
2. Between Ushant and St. Michael's. Ans. 1238′.
3. Between Diego Ramirez and C. Lopatka. Ans. 8071′.
4. Between New York and Manila. Ans. 9899′.

196. When a ship in E. long. sails east, or in W. long. sails west,

* Since the meridians are all parallel at the equator and meet at the poles, the distance between any two meridians, measured east and west, is less as the latitude is greater; that is, the absolute *number of miles*, or of feet, in a degree of longitude, is less as the latitude in which they are measured is greater. Hence, also, a given number of miles between two meridians corresponds to a greater diff. long. as the latitude in which they are measured is greater. For example, two places in lat. 10° and distant 40 miles east and west from each other, have 40′·6 diff. long. In lat. 50° two places similarly situated have 1° 2′·2 diff. long. Questions of this kind are solved by the rules of Parallel Sailing.

she evidently increases her longitude, or the distance from the first meridian. But if in E. long. she sails west, or in W. long. she sails east, she diminishes her longitude. Hence, when one longitude is given, and also the diff. long., the other longitude is easily found.

Ex. 1. A ship from long. 31° 40′ E. sails east 3° 9′: find the long. in.

Long. left........	31°	40′	E.
Diff. long.	3	9	E.
LONG. IN	34	49	E.

Ex. 2. A ship from long. 97° 45′ W. makes 1° 11′ easting: find the long. in.

Long. left	97°	45′	W.
Diff. long.	1	11	E.
LONG. IN	96	34	W.

Ex. 3. A ship from long. 0° 32′ W makes 2° 8′ easting: find the long in.

Long. left	0°	32′	W.
Diff. long.	2	8	E.
LONG. IN	1	36	E.

Ex. 4. A ship from long 178° 54′ W makes 3° 4′ westing: find the long. in.

Long. left	178°	54′	W.
Diff. long.	3	4	W.
LONG. IN	181	58	W.
Or (by No. 195)	178	2	E.

Examples for Exercise.

1. Long. left 1° 25′ W. dif. of long. 85′ E: what is the long. in? Ans. 0° 0
2. Long. left 0° 0′, diff. of long. 146′ W: the long. in is required. Ans. 2° 26′ W.
3. Long. left 0° 0′, diff of long. 122′ E: what is the long. in? Ans. 2° 2′ E.
4. Long. left 160° 20′ W. diff. of long 41° 20′ W: find the long. in. Ans. 158° 20′ E.
5. Long. left. 179° 10′ E. diff. of long. 84′ E.: what is the long. in? Ans. 179° 26′ W.

197. The COURSE *steered* is the angle between the meridian and the ship's head. The course *made good* is the angle between the meridian and the ship's real track on the surface of the sphere.

The course is reckoned from the north, towards the east or west, when the ship's head is less than eight points from the north point. The same applies to the south point. The course is measured in *points* of 11° 15′ each, or in degrees and minutes.

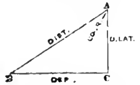
198. The track of the ship while preserving the same angle with all the meridians as she crosses them in succession, is called the RHUMB LINE.

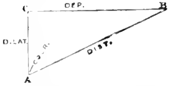
199. The DISTANCE between two places, or the distance run by the ship on a certain course, is measured in *nautical miles* of 60 to the degree of latitude. *See* p. 104, note, and Table 64 A. Three such miles make a *nautical league.*

200. The DEPARTURE is the distance in nautical miles, made good by the ship due east or west; or the distance between two places measured along their parallel.

Departure is marked east or west, according as it is made good towards the east or west, and is accordingly called easting and westing; such easting and westing being, however, expressed in *miles*, and not, like longitude, in *arc*.

Thus, if a ship sails from a place A to another as B, A B is the





distance; A C drawn N. and S., or in the meridian, shews the angle

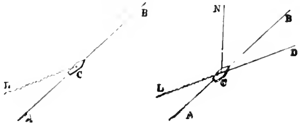
C A B the *course;* B C drawn E. and W., or perpendicular to C A, is the *departure;* and A C is the *diff. lat.*

201. The BEARING of an object or place is the angle contained between the meridian and the direction of the object, and is the same thing as the course towards it.

Taking a bearing of an object is called *setting* it.

The bearings of two objects, taken from the same place, constitute *cross bearings,* the lines of direction of the two objects intersecting or crossing each other at the place of the observer.

202. LEEWAY is the angle included between the direction of the ship's keel and the direction of the wake she leaves on the surface of the water.



Thus the vessel C, while she moves through the water in the direction of her length, in the line C B, is at the same time pressed to leeward of this line by the force of the wind, supposed in the figures to blow on the vessel's left or port side; her wake, or actual path through the water, appears therefore to windward of the line which she endeavours to keep, as is represented by the line C L. The angle A C L is the leeway.

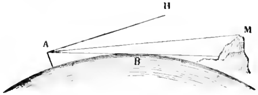
The course steered (No. 197) is the angle N C B, N C being the meridian; the course made good is N C D, the line C D being determined by producing L C.

203. The DEAD RECKONING is the account kept of the ship's place, without reference to astronomical observation. It is written D. R. for shortness.

204. The VISIBLE, or SEA HORIZON, is the apparent boundary of the surface of the water, which appears to the eye the circumference of a circle.

205. The DEPRESSION, or, as it is called by abbreviation, DIP, is the angle through which the sea horizon appears depressed, in consequence of the elevation of the spectator.

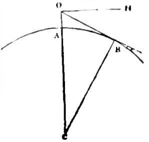
Suppose the spectator at A, above the sea, and A H a line



perpendicular to the plumb-line at A, which tends to the centre; A H is the true level, or horizontal line, and the angle H A B, included between it and the line A B, touching the sea, is the dip.

The dip depends on the distance in nautical miles of the visible horizon. Thus, to the eye 30 feet above the sea the true dip is 6′, or the distance of the horizon itself is about 6 miles. This is easily proved thus,

Let C be the centre of the earth, O the place of the observer; then the line O B drawn touching the surface at B determines B the farthest point visible to him. Draw O H perpendicular to O C, then since O B touches the circle at B, the angle C B O is a right angle (No. 138, Cor.) Hence B C A is the complement of C O B, and H O B is also the complement of C O B (C O H = 90°), therefore A C B and H O B are equal.



The depression is given in Table 8.

206. The ALTITUDE of a terrestrial or celestial object above the sea horizon is the angle included between the line drawn from the eye to the object, and the line from the eye to the horizon. Thus, the angle M A B is the altitude of the summit M. The altitude here, in consequence of the great elevation of the spectator at A, about $\frac{1}{12}$ of the radius, or 330 miles, is less than the dip, or the summit M is really below the true horizontal line A H. This may take place when, from the small height of the object with respect to that of the observer, or its great distance, it is seen very little elevated; but in most cases A M will fall above A H.

207. The rays of light which pass from any distant object on the earth suffer a change in their direction, which is called the *terrestrial refraction*, by which the object appears in general higher than its true place. This effect is, on the average, about $\frac{1}{14}$ of the intercepted arc, or distance in miles, which are minutes of a degree very nearly. Thus, an object twenty-eight miles distant is raised about 2′ above its true place. The sea horizon is thus raised by refraction, or the apparent dip (Table 39) is less than the true.

This proportion, however, is subject to great irregularity, and varies between $\frac{1}{3}$ and $\frac{1}{23}$ of the intercepted arc. The apparent elevations of the summits of high land are thus subject to great variations, depending on particular states of the air.

208. The apparent place of the sea horizon differs also in different temperatures of the sea and air. When the sea is *warmer* than the air, the horizon appears ***below*** its mean place, or that at which it appears when the air and water are of the same temperature, or the apparent dip is too small; when the sea is *colder* than the air, the horizon appears *above* its mean place,* or the apparent dip is too great.

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* Admiral W. F. W. Owen informs me that he found on one occasion, in observing a star's altitude, a change of 4′ in the place of the sea horizon, in the tropics, soon after sunset. Mr. Fisher observed a variation in the place of the horizon of 18′ in the arctic regions. In summer the ice horizon was *elevated*, not depressed; in the winter it was depressed several minutes. — (*Appendix to Captain Parry's Voyage* in 1821–3, p. 187.) These observations, however, do not all follow the rule above. A table for correcting the apparent place of the sea horizon for the difference of temperature of the sea and the air, according to the height of the eye, would

Colonel Sabine gives a table of depressions observed from the gangway of H.M.S. Pheasant, at 15ft. 1in. above the sea, in the Gulf Stream, and after leaving it.* On Dec. 5, 1822, lat. 36°½ N., long. 72°½ W., at 10h A.M., the temperature of the sea being 70°, that of the air 60°, the dip observed by Wollaston's dip sector was 4′ 57″, or 1′ 6″ more than the table. At noon the temperature of the water had changed to 62° 4, the air at 60° as before, the ship having passed from the warmer water of the stream to the colder water of the rest of the ocean, and the dip observed was 3′ 37″. From the result of his observations, Colonel Sabine considers that the navigator will be right nine times in ten in assuming that, when the sea is *warmer* than the air, the tabular dip is *too small*. In only one case, however, did this error ever amount to so much as 1′ 56″, the sea being then at 49°, and the air at 38°, or the difference 11° ; and it is important to remark that the error of the table is by no means proportional to the difference of these temperatures, which in one case was no less than 29°.

Numerous instances are on record, in the accounts of modern navigation, of errors of observation arising from variation in the place of the sea horizon.

209. Besides the vertical effect of refraction above described, some instances have been recorded of a sensible change in the *horizontal* direction of objects. Mr. K. B. Martin observed a change in the true direction of a point of land in the Azores, towards sunset. He also mentions an extraordinary change in the direction of C. Grisnez light as seen from Ramsgate at the close of a very hot day; on which occasion, also, distant objects were elongated horizontally till they seemed to separate into parts. ("Naut. Mag." 1847.)

Lieutenant Wilkes observed from the summit of Mowna Roa, the sun's horizontal diameter lengthened out to twice and a half the vertical one. ("Narrative of the United States Exploring Expedition," 1838–42.) In the Survey of the Isthmus of Tehuantepec, under Señor G. Moro, in 1842–3, the refractions at San Mateo on the Pacific, "especially the lateral ones," produced the strangest illusions.†

210. The TROPICS of CANCER and CAPRICORN are the parallels of latitude 23° 28′ N. and S. These are the dotted lines nearest the equator (fig. in p. 55). The sun is vertical at noon twice in the year to every place between the tropics, and never to any place outside of them. The space between the tropics is called the TORRID ZONE, on account of its heat.

211. The ARCTIC CIRCLE, or North Polar Circle, and the ANTARCTIC CIRCLE, or South Polar Circle, are parallels distant 23° 28′ from each pole, and are therefore in latitude 66° 32′. These are the dotted lines nearest the pole. Within these circles the sun does not set during part of the summer, nor rise during part of the winter.

The spaces within these circles are called the FRIGID ZONES, on account of the cold. The spaces between the tropics and the polar circles are called the TEMPERATE ZONES.

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be useful ; but there are scarcely any data for the construction of such a table, and the theory itself appears not to be complete.

The above variation of the place of the apparent horizon, with mirage, reflected images, and other optical illusions, were first discussed, generally as questions of unequal temperature alone, by M. Biot, Mém. de l'Institut, 1809.

* Account of Experiments to determine the Figure of the Earth. London, 1825, p. 454.

† It is easy to conceive, that if a mass of air of different density from the rest be interposed between the spectator and the object, and if also the sides or faces which he looks through be not exactly parallel, it will have the effect of a prism, and will seem to throw the object to the right or left of its true direction. If the surfaces are curved, the effect of magnifying or diminishing will occur at the same time.

CHAPTER II.

Instruments of Navigation.

I. The Compass. II. The Log and Glasses.

The necessary instruments of navigation are the **Compass**, by the aid of which the course of the ship can be directed; and the **Log**, which, with the help of sand-glasses for measuring small intervals of time, or a watch showing seconds, gives the velocity or rate of the ship, and thence the distance run in any interval of time.

I. The Compass.

212. Before the invention of the Compass, the course of the ship was directed by reference to the land, or to the position of the heavenly bodies; but when those objects were obscured, the seaman must sometimes have been much perplexed.

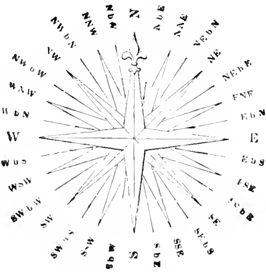
The pointing or directive property of the magnet, on which the efficiency of the compass mainly depends, appears to have been known to the Chinese, and made use of by them in travelling by land and sea, in times of remote antiquity. The ancient Greeks and Romans, though familiar with the magnet, were not apparently aware of its directive property, nor were their descendants till the beginning of the thirteenth century. About that time the seamen of the Mediterranean gradually became acquainted with the fact, that a piece of magnetised steel, shaped like and commonly called a needle, would, if allowed to turn freely about its centre, always come to rest in the same direction, and that, by reference to its pointing, they could roughly check or direct the course of the vessel.

Thus, before the seamen of those days were two problems. First, the best means of giving to the needle freedom, to take up any horizontal direction, and of indicating the direction of the ship's head relative thereto. Second, to find the exact direction of the pointing of the needle, in relation to some known standard of direction. In other words, first the perfecting of the mariner's compass; second, a knowledge of what is now called its variation.

Apparently, the earliest means used to allow the needle to take up any position in azimuth, was by thrusting it through a piece of light wood or pith, forming with it a rectangular cross;

the wood or pith being just sufficiently large to float the needle, when the cross was placed in a vessel of water. Otherwise, the needle was poised at its centre on a sharp pivot, and inclosed in some form of box. Subsequently, the necessity for keeping the box horizontal, in the varying motion of the ship, was met by gimballing the compass-box, and, for convenience, a circular disc of paper, called the fly, having a graduated circumference, was placed on the needle. The fly and the needle together was called the card. The box was generally made of brass, shaped like a basin, and had a glass cover. A mark, called the lubber-line, was placed on the fore part of the compass-box, or bowl as it was commonly called, on the inside, indicating the direction of the ship's fore-and-aft line, from the centre of the card.

The circumference of the card was divided into thirty-two divisions, called points; these were subdivided into half-points and quarter-points. The four principal points, or, as they are called, the *cardinal* points, are the North, South, East, and West; the East being towards the right when facing the North.



All the points of the compass are called by names composed of these four terms.

The points half-way between two cardinal points are called after both of these points: they are the north-east (written N.E.); north-west (N.W.); south-east (S.E.); and south-west (S.W.). These points are sometimes called quadrantal points.

A point half-way between one of these last and a cardinal point is called, in like manner, by a name composed of the nearest cardinal point and the adjacent point, N.E., N.W., S.E., or S.W. Thus the point between N. and N.E. is called north-north-east (written N.N.E.); the point between E. and N.E. is called east-north-east (written E.N.E.); and so of others.

The points *next* the eight principal points (namely, N., S., E., W., and N.E., N.W., S.E., and S.W.) take the word *by* between the name of such point and the next cardinal point. Thus the point *next* to north, on the east side, is called North *by* East; that on the West side is called North *by* West. Thus, on inspecting the compass, it is easy to see the reason of the names E. by N., S.W. by W., &c.

A *half-point*, which is the middle division between two points, is called after that one of its adjacent points which is either a cardinal point, or is the nearest to a cardinal point. Thus the middle division between N. and N. by E. is called north-*half*-east (written N. $\frac{1}{2}$ E.). Half-points near N.E., N.W., S.E., and S.W., take their name from these points. Thus we say N.E. $\frac{1}{2}$ N., and N.E. $\frac{1}{2}$ E., and N.E. by E. $\frac{1}{2}$ E.

The same holds for a quarter and for three-quarters as for a half-point.

In speaking of these divisions of the card, brevity seems to have been the chief end, rather than the habitual reading of the card from left to right, or the reverse. Thus, we may say N.E. by E. $\frac{1}{2}$ E.; but continuing to the right, instead of E.N.E. $\frac{1}{2}$ E. and E. by N. $\frac{1}{2}$ E., it is usual to say E. by N. $\frac{1}{2}$ N. and E. $\frac{1}{2}$ N.

The name of the opposite point to any proposed point is known at once, without referring to the compass, by simply reversing the names or the letters which compose it. Thus the opposite of N. being S., and that of E. being W., the opposite point to S.W. by S. is at once known to be N.E. by N. The opposite of W. $\frac{3}{4}$ S. is E. $\frac{3}{4}$ N., and so on.

Dividing the circumference of the card, by successive halving, into points, half-points, and quarter-points, was well adapted to the time, not very distant, when many helmsmen were unable to read. The quarter-point was also considered the smallest division a man, sometimes under the blinding influences of wind, rain, and spray, could well distinguish. Now, however, the cards of steering compasses are frequently divided to degrees, in addition and external to the point divisions. In cards of nine or ten inches in diameter, the degrees are sufficiently large to be distinguished by men of ordinary sight. The degrees are always marked from North or South, towards the East or West; the courses, therefore, are read from left to right, and *vice versâ*, in alternate quadrants. This is apt to cause mistakes in steering. For this reason, and for precision and brevity in speaking, writing, and signalling, there is much to be said in favour of marking the card from zero to 360 degrees, round by the right. Small compasses for shore work are thus marked generally.

Repeating the points in any order is called *boxing the compass*; to do this is, of course, one of the first things a seaman learns.

In becoming familiar with the points of the compass the learner should bear in mind that their utility is far from being confined exclusively to navigation, and that in finding his way across a new country, or through the streets of a strange city, no impressions will be so distinct or so permanent as those grounded on the points of the compass.

213. As the ship's course, which is sometimes expressed in points and sometimes in degrees, is always reckoned from the north or south point, the seaman has to refer at once, in using the Tables, to the *number of points*, or *degrees*, in any course given by *name*. The following table, which exhibits the degrees, minutes, and seconds, in each quarter-point of the compass, will be convenient for reference :—

N—E	N—W	S—E	S—W	Pts.	° ′ ″
North.	North.	South.	South.		
N ¼ E	N ¼ W	S ¼ E	S ¼ W	¼	2 48 45
N ½ E	N ½ W	S ½ E	S ½ W	½	5 37 30
N ¾ E	N ¾ W	S ¾ E	S ¾ W	¾	8 26 15
N b E	N b W	S b E	S b W	1	11 15 0
N b E ¼ E	N b W ¼ W	S b E ¼ E	S b W ¼ W	1¼	14 3 45
N b E ½ E	N b W ½ W	S b E ½ E	S b W ½ W	1½	16 52 30
N b E ¾ E	N b W ¾ W	S b E ¾ E	S b W ¾ W	1¾	19 41 15
NNE	NNW	SSE	SSW	2	22 30 0
NNE ¼ E	NNW ¼ W	SSE ¼ E	SSW ¼ W	2¼	25 18 45
NNE ½ E	NNW ½ W	SSE ½ E	SSW ½ W	2½	28 7 30
NNE ¾ E	NNW ¾ W	SSE ¾ E	SSW ¾ W	2¾	30 56 15
NE b N	NW b N	SE b S	SW b S	3	33 45 0
NE ¾ N	NW ¾ N	SE ¾ S	SW ¾ S	3¼	36 33 45
NE ½ N	NW ½ N	SE ½ S	SW ½ S	3½	39 22 30
NE ¼ N	NW ¼ N	SE ¼ S	SW ¼ S	3¾	42 11 15
NE	NW	SE	SW	4	45 0 0
NE ¼ E	NW ¼ W	SE ¼ E	SW ¼ W	4¼	47 48 45
NE ½ E	NW ½ W	SE ½ E	SW ½ W	4½	50 37 30
NE ¾ E	NW ¾ W	SE ¾ E	SW ¾ W	4¾	53 26 15
NE b E	NW b W	SE b E	SW b W	5	56 15 0
NE b E ¼ E	NW b W ¼ W	SE b E ¼ E	SW b W ¼ W	5¼	59 3 45
NE b E ½ E	NW b W ½ W	SE b E ½ E	SW b W ½ W	5½	61 52 30
NE b E ¾ E	NW b W ¾ W	SE b E ¾ E	SW b W ¾ W	5¾	64 41 15
ENE	WNW	ESE	WSW	6	67 30 0
E b N ¾ N	W b N ¾ N	E b S ¾ S	W b S ¾ S	6¼	70 18 45
E b N ½ N	W b N ½ N	E b S ½ S	W b S ½ S	6½	73 7 30
E b N ¼ N	W b N ¼ N	E b S ¼ S	W b S ¼ S	6¾	75 56 15
E b N	W b N	E b S	W b S	7	78 45 0
E ¾ N	W ¾ N	E ¾ S	W ¾ S	7¼	81 33 45
E ½ N	W ½ N	E ½ S	W ½ S	7½	84 22 30
E ¼ N	W ¼ N	E ¼ S	W ¼ S	7¾	87 11 15
East.	West.	East.	West.	8	90 0 0

214. The Azimuth Compass is a compass of superior construction, especially adapted for observing bearings. It is fitted with

two vertical vanes. The one near the eye in observing, has a narrow vertical slit, with coloured shades for observing the sun. The other vane has a wider slit or opening, having a vertical thread in the middle of it. In front of this vane is a reflector, for observing objects elevated above the horizon. The line joining the slit in one vane, and the vertical thread in the other, should pass over the centre of the card. The cards of azimuth compasses are always marked to degrees, and frequently to smaller divisions.

In the Prismatic Azimuth Compass, a magnified image of the divisions of the card is read by reflection, in a prism attached to the fore side of the near sight vane. Azimuth compasses being required for taking bearings, are placed on a tripod for shore work, and on an elevated stand on board ship.

215. In the early part of the present century, when ships and instruments for navigation were rapidly improving, the compass was still a rude instrument, and not abreast of the requirements of the seaman. In 1820 Mr. Barlow reported to the Admiralty, that half the compasses he had at their request examined, belonging to the Royal Navy, were useless. It is probable that the compasses of the Mercantile Navy were no better. In 1837 their Lordships appointed a committee to inquire into the matter, and, if possible, to find a remedy for an evil so pregnant, as they said, with mischief. This step was taken for the benefit of the Royal Navy, and the improvement which took place, both in the design and in the workmanship of the compass, in consequence of the recommendations of the Admiralty compass committee, was of immediate and lasting benefit to the public service. The Mercantile Navy was not so immediately benefited, as the proceedings of that committee were not made public. But doubtless the fact of there having been such a committee stimulated compass makers to seek information, and to apply it to the improvement of the mariner's compass.

A great difficulty to be overcome, in a compass intended to be used on board ship, is the disturbance of the card caused by the motion of the ship. The Admiralty compass committee, while insisting on extreme lightness in the fly and fittings of the card, made considerable addition to its weight, by applying more needle power than would otherwise have been desirable, in order to secure steadiness. This was a fairly successful way of meeting the motion of ships at that date. But the violent and continuous motion, subsequently caused by the general adoption of the screw propeller, has been generally met, by suspending the compass bowl by springs or india-rubber.

The difficulty of getting a compass that would be steady in small vessels and boats, led to the introduction of the Liquid Compass; that is, a compass having the bowl filled with liquid instead of air. The first practical liquid compass was patented by Mr. Crowe in 1813. It was subsequently improved by other makers, and is now, when well made, a very efficient compass for all purposes. It is especially adapted to stand severe vibration, and the shock of gun-firing. For these purposes, and for use in boats, it has not yet been excelled.

216. In 1876 Sir Wm. Thomson patented a compass, which is regarded with much favour by navigators. At the circumference of the card is an aluminium ring; the cap is held in the centre by radial silk threads, extending from it to the ring. Attached to the ring and threads is a disc of very light paper, its circumference having the usual compass graduations. All the central part of this disc is removed, still further to lessen the weight. Recognising the fact, that the power of a magnet increases relative to its weight, as the size decreases, the needles are very small. They are suspended under the card from its circumference. The entire card is not more than one-fifth to one-tenth of the weight of compass cards generally, of the same size. The friction on the pivot is, therefore, proportionally diminished.

By giving to the card no more needle power than would certainly overcome this much-diminished friction, it has a very slow period of vibration. The desirability of giving to a compass card a period of vibration that would not be isochronous with the roll of the ship, in order to maintain steadiness in a seaway, had already been pointed out by Mr. A. Smith, and by Mr. Towson. The bowl is protected from disturbance, also, by being suspended on a twisted wire gromet. This compass card, from the little friction on the pivot, is very sensitive at all times. From its slow period of vibration, it is steady when the ship is rolling; and, by reason of the suspension of the bowl, it has considerable immunity from the disturbances caused by vibration, shakes, and sudden shocks.

217. Though a compass, when supplied to a ship, should be accurate and efficient, it is desirable that the seaman should be able to satisfy himself on these points. The following essentials should be looked to, in steering and azimuth compasses, as far as they apply to each kind respectively.

The point of the pivot should always be in the same plane as the centre of the gimbals. The pivot should be sharp, or, when intended to be a little rounded, quite smooth; it should be free from rust. The cap should be sound—that is, not cracked nor perforated—and free from dust or dirt, which sometimes gets into it. Placing the card gently on the pivot, it should be deflected two or three times, through a small angle from its position of rest, to see if it always comes back to rest at the same point. This would show if the needle power is sufficient to overcome the friction on the pivot.

Select a position on shore, free from disturbances, from whence the bearing of some object is known. Measure horizontal angles from it with a sextant, or other means, to three other objects, so selected that the correct bearing of four objects, about 90° apart, may thus be known. Now turn the compass round horizontally, so that the line from the centre of the card to the lubber-line coincides, in horizontal direction, with the line from the centre of the card to each object in succession. At each position of the compass, observe the bearing of the first object, by the sight vanes. Assuming that the card is regularly divided, these observations would show whether or not a course shaped, or a horizontal bearing taken, by the compass is correct.

Placing the compass on board ship in its binnacle, see that the bowl takes up its proper horizontal position in the gimbals; that the lubber-line is vertical, and that a line from the centre of the card to the lubber-line is exactly in the same horizontal direction as the fore-and-aft line of the ship. See that the thread in the sight vane is vertical, by testing it with a plumb line; and raise and lower the reflector, and see that the reflected image of the thread coincides with the thread itself. This will show that the bearing of an object at any elevation, whether taken by direct bearing or by reflection, is correct.

Metal pivots become blunted by wear, and steel pivots are also very liable to rust; jewelled caps naturally get worn and perforated by use, especially from the long-continued working of the screw propeller. They are also liable to be cracked by sudden concussion. Heavy cards are sometimes fitted with speculum metal caps, and work on jewelled pivots. Defective caps and pivots are a fruitful source of inefficiency in compasses, and require the especial attention of the navigator.

218. At a time when ships had no compass in an elevated position, all bearings had to be taken from the steering compasses. These were low down to the deck, and therefore inconvenient for that purpose. And subsequently, when most ships had an elevated compass, its position was frequently such, that an all-round view could not be obtained therefrom. The difficulty was met by the introduction of an instrument called a dumb card, or bearing-plate. It consists of a circular plate of metal, graduated like a compass card, and so gimballed that it may be revolved round a central pivot, in a horizontal plane. Adjacent to the circumference is a mark, similar to the lubber-line of the compass. It is fitted with sight vanes, shades, and reflector, for taking bearings.

The instrument may be placed in any position from whence the object, or objects, to be observed may be seen. The greatest care must be taken to see that the line from the centre of the bearing-plate to its lubber-mark is in the exact fore-and-aft line of the ship. This may be done by referring it to some mark in the ship, exactly in the fore-and-aft line; or to some mark, such as a bollard, which, from the position chosen for the bearing-plate, is a known, small, and constant angle from the fore-and-aft line.

If the direction of the ship's head by the bearing-plate, be made to correspond with the direction of the ship's head by any compass, then the bearings taken by the bearing-plate will be the same as if they were taken by that compass. And, conversely, if the bearing-plate be turned round, so that the bearing of an object by it corresponds with its known correct bearing, the direction of the ship's head, as shown by the bearing-plate. is correct. This instrument, sometimes called a Pelorus, is extensively used.

Another instrument, called a Palinurus, is sometimes used for getting true bearings. It is, simply, the mechanical construction of the celestial sphere, with its great circles. By means of time, latitude, and declination of some heavenly body, a line in the instrument may be set to the true direction of that body. All the parts of the instrument, when that line is pointed to the body, will be in the true astronomical direction, and the bearings on the horizontal circle of the instrument will be true bearings round the horizon. A mark placed as the lubber-line will, of course, show the true direction of the ship's head. It will be seen that, with this instrument, no calculations or azimuth tables are required to get a true direction.

With respect to the use of such adjuncts to the compass, as have been briefly described, liability to secondary errors, both personal and instrumental, must be taken into account. To work directly, from a well-placed standard compass, appears by far the safest practice in navigation.

Variation of the Compass.

219. The second problem before the early navigators was, to find the direction in which the needle pointed (No. 214). When the directive property of the magnet was first brought into use by seamen, it is probable that they continued for some time to steer by the sun and stars, as before. It was only when those objects were obscured, that they had recourse to a rude form of compass, to enable them to maintain their course, till their accustomed and more reliable guides appeared again. What the compass needle was to the seamen of those days, it is to the navigator of to-day. By it he can preserve a course, without reference to the heavenly bodies, for a longer or shorter time, and with more or less accuracy, according to the perfection of his compass, and to the degree in which he is acquainted with the laws which govern its pointing.

The natural standard of direction is the meridian. The horizontal angle contained between the direction of the meridian and the direction of the needle, is called the Variation of the Compass. It is termed easterly or westerly, according to which side of the meridian the north end of the needle points.

The approximate direction of the meridian was easily seen in the northern hemisphere, by the position of the pole star. It must, therefore, have been well known, to all who noted the pointing of the compass needle, with any degree of care, that its direction did not coincide with the direction of the meridian; or, in other words, that it did not, in all places, point to the north. This fact seems to have been brought most prominently into notice by Columbus. He found, on his first voyage, in 1492, when well over towards the West Indies, that the needle pointed to the westward of north. In the seas which Columbus had hitherto navigated, as far as can be now judged, it pointed to the eastward of north. At the port in Europe from which he sailed the variation was, apparently, not less than two points easterly. Probably, therefore, it was the change, and especially its going from easterly to westerly, rather than the existence of variation, which arrested the attention of Columbus.

The first good determination of the variation, in England, was made in 1580, when the direction of the north end of the needle was about one point to the eastward of the meridian. Since that time, the variation has been observed with increasing frequency and accuracy. The following is an outline of the change in the variation in England.

Commencing in 1580 at 11° 15′ easterly, the north point of the needle moved towards the meridian, and crossed it in 1657, moving westward at the rate of 10′ annually. The north end of the needle continued to move westward, with a diminishing rate, till 1818, when it attained the limit of its western range, 24° 38′ westerly. Since that date the north point of the needle has moved to the east with an increasing rate. The variation in London is now 17° 30′ westerly, diminishing at the rate of 8′ annually.

The first attempt to give a comprehensive view of the direction of the compass needle, in all parts of the world, was made by Halley, in a chart published in 1700. This chart embraced the results of a voyage made by Halley himself, and such other information as was at that time available. Joining, by a line, the points on the earth's surface where the variation was the same, he traced, on a Mercator's chart, a series of lines of equal variation, extending over the Atlantic and Indian Oceans, and as far east as the meridian of 150°. Several similar charts, more complete and accurate, as the materials for compiling them increased in quantity and value, have since been published. The latest variation chart published by the Admiralty is all that the seaman can desire. On it the annual change of variation is also shown, enabling the navigator to obtain the variation very closely, at any date subsequent to that of the publication of the chart. Comparing Halley's chart with those which have since been made, it appears that changes in the variation, analogous to those observed in England, but of greater or lesser extent, have been going on nearly all over the world. The variation of the compass is thus shown to be a variable quantity, changing at a variable rate. Such being the case, the only way in which it is possible to make and maintain an accurate variation chart, is by the co-operation of navigators, in making and recording, for that purpose, observations of the variation of the compass, in all those parts of the world over which they may sail.

220. Besides the change in the variation, which reaches its limits in long intervals of time, and is called the secular change, there are smaller changes, called periodical. Such is the diurnal change, wherein the needle moves through a small angle to the westward during the day, and returns to the eastward during the night, in the northern hemisphere. In the southern hemisphere, a similar change takes place, but in an opposite direction. The needle is also disturbed by the aurora, and by phenomena called magnetic storms. These changes are, in the navigable parts of the globe, too small to be of any importance to the navigator. Neither is the pointing of the compass needle affected by atmospheric phenomena, such as fogs, rain, wind, or thunderstorms. But in cases where a ship has been struck by lightning, the directive property of the compass needle has sometimes been impaired or destroyed.

There is, however, one cause of disturbance of the needle which should interest the navigator. Humboldt, in the beginning of this century, observed that the needle, in certain places on land, was deflected from what may be called its normal direction, by some property in the ground. In previous editions of this work, several places are noted, where the variation was affected by the land, or by the ground in shallow water.* It is probable, from the practice of steering by the land when it is in sight, rather than by compass courses, that this disturbance of the compass needle has escaped notice in some places where it exists. It is, therefore, desirable that this unquestionable source of danger should be pointed out, that the seaman may be on his guard, when navigating near the land, or in shallow water, especially in volcanic regions. Methods of determining the variation of the compass are given in Chapter VIII.

221. To correct compass courses and bearings for variation.

The manner of doing this appears thus. Suppose one compass card to be placed directly over another, and the lower one to be *true*. Now suppose the north point of the upper compass to be drawn two points to the right of the true by easterly variation, then the North point of the upper or *magnetic* compass corresponds

* Commander W. U. Moore of H.M.S. Penguin reports a large local disturbance of the needle (55°) in 9 fathoms, 2 miles from the shore, off Port Walcott; on the N.W. coast of Australia. *See* Notice to Mariners, No. 13 of 1891.

to N.N.E. of the *true* compass, which point is to the right of N., and the South point corresponds to S.S.W. of the true compass, to the right of S., and so on. The contrary would take place with westerly variation; hence to correct a magnetic course or bearing we have this rule.

Rule. When the variation is *easterly*, apply it to the *right* of the compass course or bearing; when *westerly*, apply it to the *left*, looking from the centre of the card over the point to be corrected.

Ex. 1. Course by compass, S. $\frac{3}{4}$ W.; variation, $2\frac{1}{4}$ points easterly.
TRUE COURSE, $2\frac{1}{4}$ points to the right of S. $\frac{3}{4}$ W., or S. 3 points W., or S.W. by S.

Ex. 2. Course by compass, N. by E.; variation, 2 point westerly.
TRUE COURSE, 2 points to the left of N. by E., that is, N. by W.

Ex. 3. Course or bearing by compass, N. 84° E.; variation, 19° W.
TRUE COURSE, N. 65° E.

Ex. 4. Course by compass, S. 4° E.; variation, 17° E.
TRUE COURSE, S. 13° W.

To reduce a true course or bearing to the compass course or bearing, apply the variation the *contrary way* to that directed above.

Ex. 1. True course, N.E. by E.; variation, 1 point easterly.
COURSE BY COMPASS, N.E.

Ex. 2. True course, E. $\frac{3}{4}$ N.; variation, $1\frac{3}{4}$ point westerly.
COURSE BY COMPASS, E. by S.

Ex. 3. True course, North; variation, 18° easterly.
COURSE BY COMPASS, N. 18° W.

Ex. 4. True course, West; variation, 21° westerly.
COURSE BY COMPASS, N. 69° W.

Deviation of the Compass.

222. From the earliest times it was known that if a magnet, or a piece of ordinary iron, were brought near to a compass, it would deflect the needle in its pointing, and so make the compass indications erroneous. Compasses on board ship, therefore, were not placed near to each other, and iron was rigorously kept away from their vicinity. With these precautions, though accidents sometimes happened from iron in the vicinity of the compass being overlooked, ships were navigated with a fair amount of security. But as iron became increasingly used in the construction of ships, and by the introduction therein of steam engines, with their boilers and funnels, it was no longer possible to navigate, without systematically allowing for the deflection of the compass needle caused thereby.

The horizontal angle, which the needle is deflected by the iron in or of the ship, is called the Deviation of the Compass. It is named easterly or positive (E. or +), when the north end of needle is deflected to the eastward; and westerly or negative (W. or −), when deflected to the westward. The mode of ascertaining and applying the deviation of the compass, is the next problem to engage the attention of the student of navigation.

Within half a century of the present time, many navigators doubted the existence of the deviation of the compass; or, while admitting its existence, denied that it was of any practical importance. And the belief was not uncommon, that it was a constant error--that is, that it was the same in amount with the ship's head in any direction. Those, however, who had studied the subject, or whom circumstances had made familiar therewith, acknowledged its importance, and recognised the necessity of ascertaining the deviation of the compass, with the ship's head in all directions.

223. There are three standards from which to reckon an angle of direction. First, from the meridian, the direction of which can always be ascertained astronomically. A course or bearing thus reckoned, is called a true course, or true bearing. Second, from the direction of the magnetic north; that is, from the direction of a magnetic needle, when uninfluenced by any contiguous iron, or by any such local disturbances as are mentioned in No. 220. A course or bearing thus reckoned, is called a magnetic course or bearing. Third, from the direction of the compass needle, as shown by a compass which is instrumentally correct, placed in any position. A course or bearing thus reckoned, is called a compass course or bearing.

The prefix correct may be placed to either of these quantities. The terms correct true, correct magnetic, correct compass, are used to distinguish the exact angles from those more or less approximate. The student must not confuse correct compass with magnetic. A correct compass course or bearing means a course or bearing accurately observed, with an accurate compass, regardless of any disturbance by which the compass may be influenced.

224. From the fact that compasses, in different parts of a ship, gave different indications, came the necessity for navigating by one especial compass, placed in a selected position. Such a compass is called the Standard Compass. It should be an azimuth compass, that is, one fitted for observing bearings; and one essential of its position is, that from it bearings can be taken all round the horizon, and at any altitude.

Turning a ship round, so as to place her head on all points of the compass in succession, for the purpose of ascertaining the deviation, is called swinging the ship. A ship may be warped or towed round, when lying at anchor or at moorings; or advantage may be taken of her turning with the tide. Wherever there is room, it may be convenient to steer a ship round under steam. It is in all cases desirable that the ship should be checked in her swinging, and steadied on the point on which it is desired to obtain the deviation.

As the variation of the compass is determined by comparing the true bearing of an object with its magnetic bearing, so the deviation of the compass is ascertained by comparing the magnetic bearing with the compass bearing—the compass, at the time, being deflected by the iron in and of the ship only. Any other disturbance, such as from the proximity of other ships or masses of iron, or the irregular influence of the land, is not deviation according to the definition already given.

The first problem is, therefore, to determine the magnetic bearing of some object external to the ship. The sun is very commonly used; the true bearing is easily found, and the variation being applied thereto, gives its magnetic bearing. A distant mark on the land may also be used; its true bearing may be found by the chart, or by measuring and applying the horizontal angle or difference of bearing between it and the sun, and the magnetic bearing by further applying the variation. A third method is to have a correct compass in a convenient position on shore, where it is free from magnetic disturbances. Then the bearing of that compass being taken from the standard compass, and the bearing of the standard compass being simultaneously taken from the shore compass, the deviation of the standard compass is found by comparison.

These methods are spoken of as, swinging by the sun, swinging by distant mark, and swinging by shore compass. When using a distant mark, it should be so far away that the radius of the circle, along the circumference of which the standard compass moves as the ship goes round, subtends a smaller angle than is of practical consequence in navigating. Otherwise the bearings must be corrected for parallax.

There are many places where the true direction of lines, on which two known and conspicuous marks appear in one, are known. These lines, called transit lines, offer especial facilities for ascertaining the deviation.

Looking from the centre of the card, if the bearing shown by the compass is to the left of the magnetic bearing, the needle is obviously deflected to the right, and the deviation consequently called easterly. If the bearing shown by the compass is to the right of the magnetic bearing, the needle must be deflected to the left, and the deviation westerly.

225. Though the deviation of other compasses is not of so much importance as that of the standard, it is usual to note the direction of the ship's head, as shown by them, when it is on each point by the standard. The deviation is usually tabulated for reference, in some form similar to the following, which is commonly called a Deviation Table.

Head by Standard Compass	Deviation of Standard Compass	Direction of Head by other Compasses		
		Port Steering	Starboard Steering	Bridge Compass

The bearing-plate is frequently used in swinging. The vanes on the bearing-plate, being set to the known magnetic bearing of the sun, distant mark, or shore compass, the magnetic direction of head is shown by the lubber mark, when the plate is turned round so that the vanes point to the object. Thus, the deviation of the compasses on the magnetic points is shown, and may be tabulated as follows :—

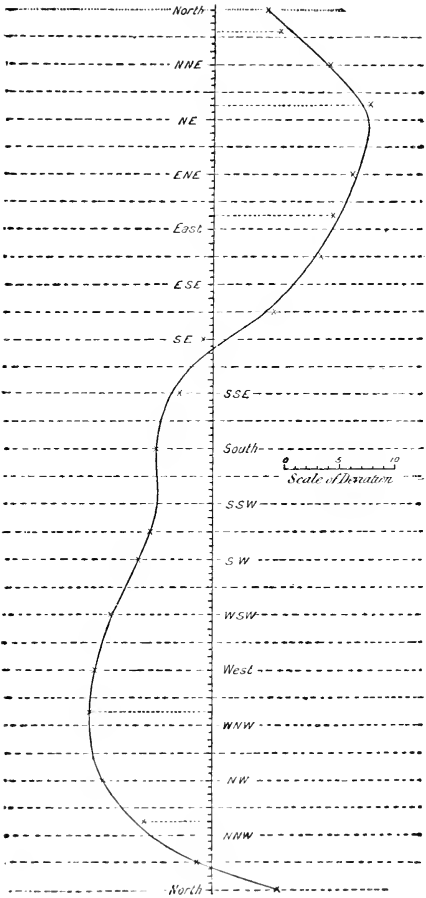
Head Magnetic	Direction of Head by Compasses			
	Standard	Port Steering	Starboard Steering	Bridge Compass

226. It is customary to form a deviation table from observations made on each point. But it may be convenient, or necessary, to form such a table with fewer observations, such as on every second or third point. Further, it may not be possible to get the observations exactly on the points. The problem, therefore, is to form a deviation table with few observations, irregularly distributed round the compass.

This is done by drawing a curve of deviations in the following manner. Draw a vertical line on paper, and divide it as a compass card is divided. The vertical line will thus represent the circumference of the card unrolled, and formed into a straight line. Through each compass point draw a line at right angles to the vertical line. On these lines, with any convenient scale, lay off the deviation found on each point. On parallel lines, passing through any intermediate degree or division of the point, lay off the deviation found thereon. Easterly deviation to be measured from the vertical line to the right, and westerly deviation to the left, marking, by a cross or otherwise, the positions thus determined. Now draw a line which, without being irregular in direction, passes most nearly through the several marks. This line, in practice, will always be a curve. The distance of the point of intersection of this curve with any point line, from the vertical line, will give the deviation on that point, using the same scale as before.

Example.—The following deviations having been observed, find the deviation on each compass point.

	°	′			°	′	
North	5	0	E	South	5	0	W
N ¾ E	6	0	E	SW b S	5	0	W
NNE	10	0	E	SW	5	30	W
NE ½ N	14	0	E	WSW	8	0	W
ENE	12	0	E	West	10	0	W
E ½ N	10	0	E	W b N ½ N	11	0	W
E b S	9	30	E	NW	10	0	W
SE b E	6	0	E	NNW ½ W	6	30	W
SE	1	0	W	N b W	1	0	W
SSE	2	30	W	North	5	0	E


North
NNE
NE
ENE
East
ESE
SE
SSE
South
0 5 10
Scale of Deviation
SSW
SW
WSW
West
WNW
NW
NNW
North

227. Plotting these observations in the manner directed, and as shown in the foregoing diagram, the following table of deviations is obtained.

	° ′			° ′	
North	5 0	E	South	5 0	W
N b E	7 45	E	S b W	5 0	W
NNE	10 0	E	SSW	5 0	W
NE b N	12 15	E	SW b S	5 0	W
NE	13 30	E	SW	5 30	W
NE b E	13 30	E	SW b W	6 30	W
ENE	12 45	E	WSW	7 45	W
E b N	11 45	E	W b S	8 45	W
East	10 30	E	West	9 45	W
E b S	8 45	E	W b N	10 30	W
E b E	7 15	E	WNW	10 45	W
SE b E	4 30	E	NW b W	10 30	W
SE	0 45	E	NW	9 45	W
SE b S	2 0	W	NW b N	8 0	W
SSE	3 30	W	NNW	5 15	W
S b E	4 30	W	N b W	1 0	W

In the diagram shown, the vertical scale is made small as compared with the horizontal scale, in order to get it within the limits of the page. A sheet of ordinary ruled foolscap will be found very convenient for plotting deviations to form the curve.

228. The methods of ascertaining the deviation having been explained, the following are directions for applying the same to a compass course or bearing, so as to obtain the magnetic course or bearing.

The ship's head being on any compass point, and the deviation on that point being easterly, that deviation must be allowed to the right, to find the magnetic direction of the ship's head; and also to the right of any bearing taken by compass, to find the magnetic bearing. If the deviation on the compass course is westerly, it must be allowed to the left, to find the magnetic course or bearing.

Example.—Ship's head E.N.E. by compass, a point of land bore N. 10° W. What is the magnetic direction of the ship's head, and the magnetic bearing of the point, the deviation being as given in table 227?

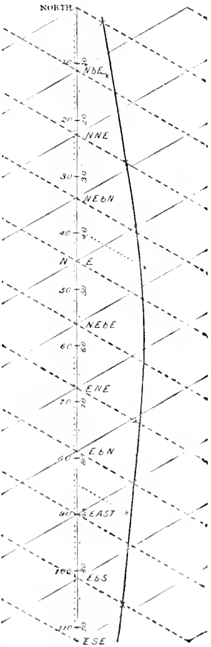
The deviation on E.N.E. is 12.45 E., which allowed to the right of N. 67.30 E., gives N. 80.15 E. as the magnetic direction of the ship's head; and allowed to the right of N. 10.0 W., gives N. 2.45 E. as the magnetic bearing of the point. In the same way, head being N.W. and bearing S. 40 E., the deviation on N.W. is 9.45 W., which allowed to the left, gives N. 54.45 W. as magnetic direction of ship's head, and S. 49.45 E. as magnetic bearing of point.

To turn magnetic courses or bearings into compass courses or bearings, it is obvious that the deviation should be allowed the opposite way. That is, easterly deviation to the left, and westerly deviation to the right.

229. To facilitate turning compass courses or bearings into magnetic courses or bearings, and the reverse, certain graphic methods are sometimes used. The most common is one called, from its inventor, Napier's diagram. The example given, wherein are plotted, through a quadrant, the observations given in No. 226, shows the use of this diagram for the purpose named, as well as for forming a curve of deviations from few observations.

The dotted compass point lines intersect the vertical line, at an angle of 60°, and the vertical scale and deviation scale are equal. Therefore, if the deviation found on any compass point be laid off on one of the dotted lines, or on a line parallel thereto, and, from the point reached, a line be drawn making an angle of 60° with the compass point line, it will intersect the vertical line at the magnetic point. And, *vice versâ*, if the deviation on a magnetic point be laid off on one of the plain lines, or on a line parallel thereto, the return line, drawn as before, will reach the vertical line at the compass point. The three lines form an equilateral triangle, of which the difference between compass and magnetic forms the base, the other sides being equal thereto, and to the deviation due to the direction of head, whether given by compass or magnetic.

NAPIER'S DIAGRAM.

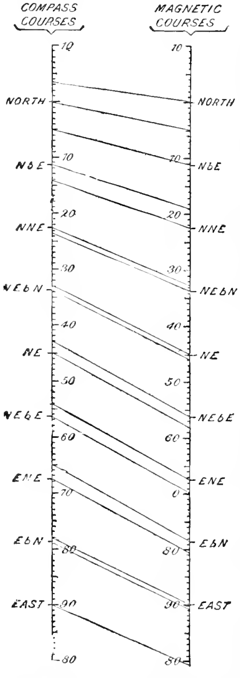


230. Another method, called the straight line method, is due to Mr. Archibald Smith. It is only useful for showing, at a glance, the magnetic course equivalent to any given compass course, and *vice versâ*, when the deviation is known. It consists merely of two parallel vertical lines, each divided as the circumference of a compass card is divided. Straight lines are

drawn, from the compass points on one line to the magnetic points on the other.

In the annexed example, the deviation table through one quadrant, given in No. 227, is thus treated.

STRAIGHT LINE DIAGRAM.



If a ship be steering any compass course, shown on the left-hand column, the corresponding magnetic course is shown on the right-hand column. And if it is desired to steer any magnetic course, shown on the right-hand column, the required compass course is shown on the left-hand column.

231. A third method is to have two prints of compass cards, one laid on the other. The upper card somewhat smaller than the lower, and capable of being rotated about the common centre. The lower card, being fixed, may be considered as representing either true, or magnetic, courses or bearings.

Consider the lower card to represent true courses and bearings, and the north points of the two cards together. Conceive the north point of the upper card, moved through an arc equal to the variation, away from the north point on the lower card, to the right when the variation is easterly, and to the left when the variation is westerly. Magnetic courses and bearings on the upper card, and true courses and bearings on the lower card, will now be coincident.

Similarly, if the lower card be considered as showing magnetic courses or bearings, and the north points of the cards be separated by an arc equal to the deviation, then the compass courses and bearings on the upper card, will coincide with magnetic courses or bearings on the lower card.

Diagrams on which curves of deviation can be drawn, so as to show indifferent observations, and thus eliminate their effects, or to form the curve from few observations, are of undoubted value to the seaman. But it is a question, whether any means such as have been described, for turning magnetic courses into compass courses, or the reverse, are of ultimate benefit. The habit of considering the effect on courses and bearings, of the north point, and consequently the whole circumference of the card, being turned right or left, from what may be considered its proper position, so as to have a clear conception thereof in the mind, will make the seaman independent of rules, and of all such semi-mechanical methods.

Adjustment of the Compass.

232. If the increase of iron put into ships had been limited to engines and boilers, it is possible that a compass might have been so placed, in most ships, that the deviation would have been comparatively small. Seamen might have continued to navigate with confidence, by ascertaining and applying the deviation. But when ships were built with iron beams, iron frames, or wholly of iron, it was no longer possible to evade a deviation so large as to be unmanageable; and steps had to be taken to correct, or, as it is now called, adjust, the compass.

This operation is generally performed by practised compass adjusters; but many rightly think this is essentially the duty of a seaman, and that he should also have sufficient knowledge of magnetism to enable him to select the best position for the compasses of a ship. In a book in which teaching navigation is the main object, magnetism can only be treated with brevity; but it is hoped that the navigator will find herein all that is required for his guidance.

The horizontal pointing of the compass needle has been shown to be of the utmost importance to the navigator. For the right understanding of the magnetism of iron ships, however, and its effect on the compass, some further knowledge of the pointing of the magnetised needle, and the cause thereof, is necessary.

In the year 1576, Robert Norman, a mathematical instrument maker, of London, discovered that a needle, however nicely balanced, would, after being magnetised, depart from the horizontal, and assume a position within 20° of vertical. By careful observations he found that the needle in London, at that date, pointed, with its north end downward, 71°·50′ from the horizontal. Since that time, observations have been made nearly all over the world. It is found that the needle is horizontal only on a line round the earth, not far from the equator. Going from this line to the northward, the needle points with its north end downwards; and going to the southward, with its south end downwards. The angle of inclination, in both cases, increases, till in a position in each hemisphere, about 18° from the earth's poles, the needle becomes vertical. These positions are called Magnetic Poles.

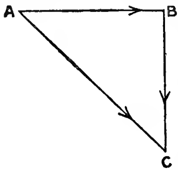
This angle of inclination to the horizontal is called the Dip. It is named positive, or +, when the end towards the north magnetic pole is the lower, and negative, or −, when the end towards the south magnetic pole is the lower. Like the variation, the dip is found to change with time, and other circumstances.

In the adjacent maps, lines of equal dip are drawn. The line whereon the dip = 0, is called the magnetic equator; and the lines of equal dip may be considered as parallels of magnetic latitude. The lines running nearly north and south show the horizontal direction the needle lies in, and may be considered as magnetic meridians. These lines converge to the magnetic pole in each hemisphere. For the use of seamen, there is no better way of giving the variation of the compass, than by lines of equal variation, as drawn on the variation chart (No. 238); but the lines here shown give a more direct representation of the pointing of the compass needle.

233. In the beginning of the present century it became known, chiefly through the researches of Humboldt, that the strength, or force, with which the needle points is not the same in all parts of the earth. It may be stated, generally, that this force is least about the equator, and, like the dip, increases towards the poles. Also, like the variation and dip, it is not constant in value at the same place.

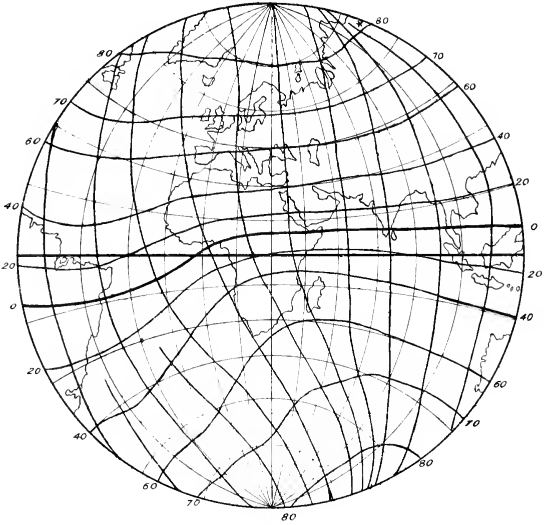
The line whereon the magnetic force is least, coincides nearly with the magnetic equator; but there are apparently, in each hemisphere, two points where the force is greater than in the surrounding regions, neither of which coincides with the magnetic pole.

As the earth's force is not horizontal, except at the magnetic equator, it is convenient to reckon, or resolve, as it is called, that force in the horizontal and vertical directions. If the length of the line A C represents the earth's force, and the angle A be equal to the dip, then the horizontal line A B, and the vertical line B C, will in length represent, respectively, the horizontal and vertical components of the earth's force. These quantities are usually called the Horizontal Force, the Vertical Force, and the Total Force. Of these quantities and the dip, if any two are known, the other two may be found by the ordinary processes of trigonometry.



As previously stated, the dip and total force increase, going away from the magnetic equator; but it is evident that when the dip is 90° the horizontal force must vanish, whatever the total force may

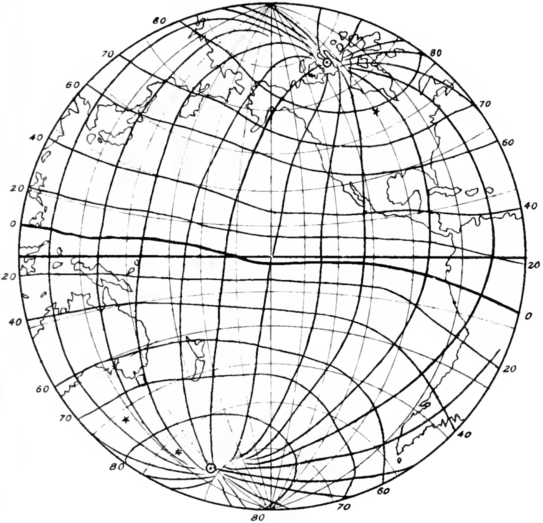
Hemisphere from 60° W. to 120° E. Longitude.



Maps showing the **Magnetic Equator**, lines of **Equal Dip**, and **Horizontal Direction** of the **Compass Needle**. The parallels of latitude and the meridians are drawn at every fifteen degrees of latitude and longitude; the figures at the circumference denote the dip in degrees along the respective magnetic parallels; and the direction of the magnetic meridians, compared with the direction of the geographical meridians, shows the variation.

Between pp 82 & 83

Hemisphere from 120° E. to 60° W. Longitude.



The points (⊙) to which the magnetic meridians converge are the magnetic poles, sometimes called, from the dip thereat being 90°, the poles of Verticity. The points (✱) show the approximate position of the foci of maximum force. It is remarkable that these six points are within 160° of longitude.

These maps, and the following table of horizontal force, are based on the good work on this subject done by the late Sir F. Evans, R.N.

be. The dip and total force, therefore, increase together in such a manner that the horizontal force continually diminishes.

The horizontal force is the only part of the earth's force by which the compass card maintains its due position. The seaman is generally satisfied if this condition is fairly answered; but he must be sometimes painfully aware, from what is called the sluggishness of his compass, that this force is, at best, very feeble.

The following table gives the comparative value of the horizontal force, in different positions; the maximum value being considered as unity.

COMPARATIVE VALUE OF HORIZONTAL FORCE
Maximum Value equal Unity

Latitude	East Longitude												
	0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180°
N 60°	0·40	0·41	0·43	0·44	0·44	0·43	0·42	0·43	0·44	0·45	0·47	0·49	0·48
50	0·49	0·52	0·55	0·57	0·58	0·58	0·58	0·57	0·57	0·59	0·60	0·60	0·59
40	0·60	0·64	0·68	0·70	0·73	0·75	0·75	0·75	0·74	0·73	0·71	0·70	0·68
30	0·71	0·75	0·79	0·83	0·87	0·89	0·90	0·89	0·87	0·84	0·82	0·80	0·76
20	0·78	0·81	0·86	0·90	0·94	0·97	0·97	0·96	0·94	0·92	0·89	0·86	0·84
10	0·82	0·85	0·88	0·90	0·93	0·97	1·00	1·00	0·99	0·97	0·94	0·92	0·90
0	0·79	0·79	0·80	0·83	0·87	0·90	0·96	1·00	1·00	1·00	0·98	0·97	0·95
S 10	0·70	0·70	0·70	0·72	0·76	0·82	0·88	0·92	0·96	0·98	0·98	0·97	0·96
20	0·61	0·59	0·59	0·60	0·64	0·71	0·77	0·82	0·87	0·90	0·91	0·91	0·90
30	0·56	0·54	0·52	0·53	0·54	0·58	0·62	0·68	0·71	0·75	0·78	0·81	0·82
40	0·55	0·51	0·49	0·48	0·49	0·50	0·51	0·54	0·55	0·57	0·62	0·65	0·68
50	0·54	0·50	0·47	0·44	0·43	0·42	0·41	0·39	0·38	0·39	0·43	0·47	0·52
60	0·53	0·49	0·46	0·42	0·39	0·36	0·32	0·27	0·20	0·20	0·24	0·30	0·37

Latitude	West Longitude												
	0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180°
N 60°	0·40	0·37	0·33	0·29	0·22	0·12	0·10	0·20	0·29	0·38	0·43	0·46	0·48
50	0·49	0·45	0·41	0·37	0·34	0·32	0·36	0·43	0·49	0·54	0·55	0·57	0·59
40	0·60	0·55	0·50	0·48	0·47	0·50	0·56	0·60	0·64	0·65	0·65	0·66	0·68
30	0·71	0·66	0·62	0·61	0·65	0·71	0·77	0·80	0·80	0·77	0·74	0·74	0·76
20	0·78	0·74	0·72	0·72	0·77	0·85	0·90	0·90	0·88	0·85	0·82	0·82	0·84
10	0·82	0·79	0·77	0·79	0·84	0·89	0·94	0·95	0·92	0·89	0·89	0·90	0·90
0	0·79	0·78	0·77	0·80	0·83	0·89	0·92	0·93	0·92	0·90	0·92	0·93	0·95
S 10	0·70	0·71	0·73	0·76	0·80	0·84	0·87	0·88	0·89	0·88	0·91	0·93	0·96
20	0·61	0·65	0·68	0·70	0·74	0·79	0·82	0·84	0·85	0·87	0·88	0·90	0·90
30	0·56	0·60	0·63	0·67	0·70	0·76	0·77	0·78	0·78	0·80	0·81	0·82	0·82
40	0·55	0·59	0·63	0·67	0·71	0·74	0·75	0·73	0·71	0·70	0·70	0·70	0·68
50	0·54	0·59	0·63	0·69	0·72	0·73	0·72	0·68	0·63	0·61	0·59	0·56	0·52
60	0·53	0·58	0·63	0·68	0·71	0·71	0·67	0·60	0·55	0·50	0·46	0·42	0·37

234. In dealing with the subject of compass adjustment, it will sometimes be useful for the seaman to know the value of the force with which the needle points on board ship, compared with the force with which it points on shore; or the force with which

it points when the ship's head is in one direction, compared with the force with which it points when the head is in other directions. It is necessary, therefore, to show how comparative magnetic force is measured. If a magnetised needle, balanced on its centre, be disturbed from its position of rest, it will, like a pendulum, vibrate through diminishing arcs, till it again comes to rest. The speed of the needle is increased when the magnetic force is increased; the force being proportional to the square of the speed of the needle. That is, if the needle in one position makes 10 vibrations in any given time, and in another position makes 12 vibrations in the same time, the magnetic force in the first position is to the magnetic force in the second position as 10^2 is to 12^2.

It is convenient to measure the horizontal force and the vertical force separately. The horizontal force is measured by means of a flat and pointed needle, about three inches long. It has a jewelled cap at its centre, which works on a sharp pivot. It must be used in a covered box, or compass bowl, to protect it from the motion of the air. It is brought horizontal by a small weight, counterbalancing the dip, and so vibrated in the horizontal plane.

Horizontal force may also be measured by deflection. If a magnet be placed at right angles to the direction of the needle, the magnet will deflect the needle through a certain angle, depending upon the strength of the magnet, compared with the horizontal force. The smaller the force, the larger the angle of deflection of the needle, the force being as the cosine of the angle of deflection. Or the deflecting magnet may be moved round, and kept at right angles to the compass needle, and the horizontal force measured by the maximum deflection the magnet is capable of producing, when thus applied.

Vertical force is measured by means of a Dip Circle. This is an instrument having a flat pointed needle, with an axle passing through its centre of gravity, about which it can rotate in a vertical plane; the axle being supported at the centre of a graduated circle. If the circle is placed in the vertical plane of the magnetic force, the needle will stand in the direction of that force, showing the dip, if it be acted on by the earth's force only. A small weight placed on the upper arm of the needle, bringing it horizontal, will be a measure of the vertical force.

If the circle is placed at right angles to the plane of the magnetic force, the needle will hang vertically, where there is any vertical force, and in this position may be vibrated, so as to measure that force.

Measuring either horizontal or vertical force by vibration, the initial arc should be the same, in any positions wherein it is desired to compare those forces. The effects of friction, and the resistance of the air, are to cause the needle to take a little more time, in going through the larger arcs than the smaller, and ultimately to bring it to rest. The smallest arcs which can be conveniently used give the best results.

235. Studying the phenomena of the pointing of the magnetised needle on the earth's surface, and comparing them with the effects of one magnetised needle, or steel bar, on another magnetised needle, or steel bar, the conviction gradually gained ground, that the earth is, or has the properties of, a large magnet. Those properties are two. First, Attraction and Repulsion: the property by which one magnet will attract and repel another, according to definite laws. Second, Induction: the property by which a magnet can impart magnetism, and so convert into a magnet any piece of iron or steel, either by contact or mere proximity.

The property of attraction and repulsion may be shown, by bringing two compass cards near to each other. The north part of one card will push away or repel the north part, and attract or draw towards it the south part, of the other. The ends of magnets are called poles, and we express the law of attraction and repulsion by saying, like poles repel, and unlike poles attract, each other.

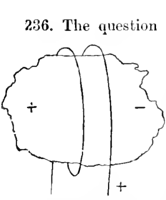
This attraction and repulsion may be due to two different kinds of magnetism in the poles, or to an excess of magnetism in one pole as compared with the other, or it may be a magnetic state, depending upon neither one cause nor the other. It will be convenient to speak of the magnetic state of the north pole of the compass needle as positive, indicating it by the sign +, and of that of the south pole as negative, indicating it by the sign −.

The pointing of the magnetised needle appears to be, the direction it takes up in obedience to the law of attraction and repulsion existing between it and the larger magnet, the earth. Also, the increasing strength, with which the needle is found to point as the latitude increases, appears due to the approach to the magnetic poles of the earth.

By the law of induction, a magnet when brought near to any piece of unmagnetised iron, induces magnetism therein; the near pole of the magnet, and the proximate part of the iron, having magnetism of opposite kinds. The similar magnetism to that of the near pole of the magnet is found in a remote part of the iron. Applying this law to the earth as a large magnet, the magnetism of iron and iron structures is apparently due to induction from the earth, and the end or part of iron which is towards the north will have positive magnetism.

In dealing with the magnetism of iron ships, this property of induction, hitherto little thought about by seamen, becomes of great importance. The earth's magnetic force, by inducing magnetism in the iron of a ship, is the source of all magnetic disturbances of the compass.

236. The question as to how the earth became magnetised will perhaps come into the mind—possibly it is, or was, magnetised by induction, from some far distant cause. But magnetism may be induced by electricity. If an insulated wire is passed round a piece of iron, and the wire be considered as conveying an electric current flowing from positive to negative, the iron will become magnetised, and have positive and negative powers, as shown in the figure.



If the trade winds flowing round the earth from the eastward, be considered as acting as a positive electric current, the earth would be magnetised with a negative pole to the north, and a positive pole to the south. Whether it is thus magnetised or not, the idea will aid the memory as to the magnetic state of the earth, show how magnetic forces may be generated by electricity, and suggest the possibility of compass disturbance, by the increasing use of electricity on board ship.

237. All iron is capable of receiving magnetism by induction from the earth. If the iron remain a long time in the same position, or if it be hammered or subjected to mechanical violence, part of the induced magnetism will remain. That is, the iron will show polarity in the same parts, after it has been moved into another position, relatively to the line of the earth's force.

All magnetism, therefore, may be called induced magnetism. That which instantly passes away, when the inducing cause no longer acts, is called transient magnetism. That which remains for a longer or shorter time, is generally called permanent magnetism. The term permanent, in this extended sense, means all magnetism that is not transient. The terms trans-permanent, sub-permanent, and permanent, may be used to indicate increasing degrees of permanency, if desired. It is, however, a question whether anything is gained by thus multiplying terms, as no definite line of separation can exist.

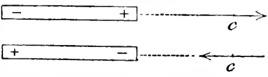
Speaking generally, iron will receive or part with magnetism more or less readily, according as it is soft or hard. Hard iron or steel, when magnetised, will retain its polarity for a very long time.

238. The disturbing effects of iron on a compass, being caused by magnetism induced in the iron by the earth's magnetism, the possibility of so placing iron about a compass on board ship as to counteract the effect of the iron of the ship, is the problem of compass adjustment.

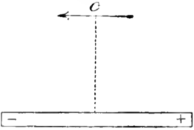
Professor Barlow was the first to deal practically with compass adjustment, and the problem was subsequently completely solved by Professor Airy in 1839. That gentleman gave the results of his researches and experiments in the following words: 'By placing a magnet so that its action will take place in a direction opposite to that which the investigations show to be the direction of the ship's independent magnetic action, and at such a distance that its effect is equal to that of the ship's independent magnetism, and by counteracting the effect of the induced magnetism by means of the induced magnetism of another mass [according to rules which are given], the compass may be made to point exactly as if it were free from disturbance.' Briefly, this statement is to the effect, that the permanent magnetism of the ship may be counteracted by the permanent magnetism of steel magnets, and the transient magnetism of the ship by the transient magnetism of iron; the magnets and iron being placed near the compass, according to definite rules.

In order to be able to consider together, the disturbing effects of the iron of the ship on the compass, and the action of magnets and iron in counteracting the same, a brief explanation of the latter is necessary.

239. Magnets, when used to adjust a compass, are applied, generally, either end on, or, as it has been termed, broadside on. If a magnet be placed near a compass, so that the centre of the needle is in the line of the magnet, the effect of the magnet is to cause a force pushing away the north point of the needle, if the positive end of the magnet is presented, and drawing the north point of the needle towards the magnet, if the negative end is presented. In the figure, if *c* represent the centre of the compass needle, the arrows represent the direction of the force on its north end. This is called the end-on position of the magnet.



If a magnet be placed near a compass, so that the centre of the needle is in the same plane as the magnet, and on a line drawn from the middle of the magnet, perpendicular to its direction, the effect of the magnet is to cause a force parallel to itself, pushing the north end of the needle away from the positive end of the magnet. In the figure, if *c* be the centre of the compass needle, the arrow shows the direction of the force on its north end. This is sometimes called the broadside position of the magnet.



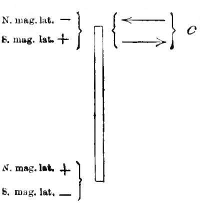
Magnets used for compass adjustment are made of hard steel, and well magnetised. Their magnetism may be considered as permanent. Thus, by means of a magnet, a permanent magnetic force can be produced, pushing the north end of the compass needle in any desired direction.

240. The iron used in adjusting compasses should be soft malle-

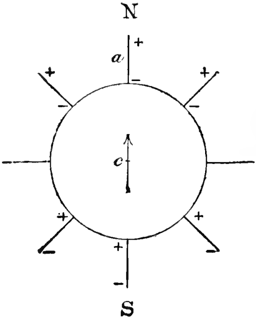
able iron, so that magnetism is readily induced therein by the earth's force, and readily parted with; that is, it does not become permanent.

It is used for two purposes. For one purpose, it is in the form of an upright bar, placed, generally, before or abaft the compass. For another purpose, masses of chain or scrap iron in boxes, cylinders, or spheres, are used. These are placed beside the compass, on the same level as the needle.

241. The action of the upright bar depends upon the earth's vertical force. In north magnetic latitude, the lower end has positive magnetism, and the upper end negative magnetism. On the magnetic equator the bar may be considered as unmagnetised. In south magnetic latitude, the lower end has negative magnetism, and the upper end positive magnetism. Therefore a magnetic force in any direction can be produced, acting on the north end of the compass needle, varying in strength with the earth's vertical force, by placing the upper end of the bar in a suitable position. It is generally desired to make this force horizontal, as shown in the figure, where *c* is the centre of the compass needle. After Captain Flinders, R.N., who was the first to propose this, or, indeed, any mode of counteracting the effect of the ship's iron on the compass, iron thus used is called a Flinders bar.



242. The action of iron placed beside a compass, is not quite so simple as that of the Flinders bar. In the fig. let *c* be the centre of the compass needle, and the circle the outer circumference of the binnacle. Let *a* represent a horizontal iron rod, placed radially north of the centre of the compass. In this position it will be magnetised by induction from the earth—the north end of the rod with positive magnetism, and the south end with negative magnetism. It will cause no deflection of the needle, because the force is in the line of the needle. It will, however, increase the force with which the needle points.



Conceiving the rod to be moved round the needle to the right, as the spokes of a wheel move round its centre, it will be seen that the amount of magnetism in the rod will diminish as it goes round, till in the east position it may be considered as without magnetism. But as the rod leaves the north position, so the magnetic force of the rod, by being inclined to the needle at a greater angle, has a greater proportional effect in deflecting it. From the combined action of these two causes, the maximum deflection of the needle occurs when the rod is in the N.E. position.

Following the rod round, and noting the magnetism induced therein by the earth's magnetism, and the effect of the magnetic force, thus generated in the rod, in deflecting the needle, the following results will appear:—

Rod North or South of the centre of the needle. Increase of force, no deflection of the needle.

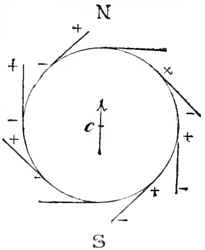
Rod N.E. or S.W. Increase of force, maximum easterly deflection of the needle.

Rod East or West. No effect on the needle.

Rod S.E. or N.W. Increase of force, maximum westerly deflection of the needle.

Thus it will be seen, that the effect of the rod is to cause a deflection of the needle, easterly and westerly in alternate quadrants, and to increase the mean magnetic force. It will also be seen, that the effect of two rods opposite to each other, is to double the effect of one.

243. Another instructive example of the effects of iron moving round a compass is that of a similar rod placed tangentially. Following the rod round, and noting the magnetism induced therein, and the effect thereof on the compass needle, as in the figure, the following results will be seen:—



Near end of the rod North or South of the centre of the needle. No effect.

Near end of the rod N.E. or S.W. of the centre of the needle. Westerly deflection of the needle.

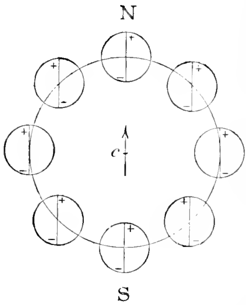
Near end of the rod East or West of the centre of the needle. Maximum westerly deflection of the needle.

Near end of the rod S.E. or N.W. of the centre of the needle. Westerly deflection of the needle.

In this example, as in 242, the effect of two rods in opposite positions is to double the effect of one.

When two rods thus placed tangentially, having their near ends at North and East, or in any positions 90° apart, revolve about the compass together, one rod will cause a maximum deflection of the needle, when the other rod has no effect thereon. As the effect of one rod increases, the effect of the other decreases; and the combined effect of the two rods, thus revolving together, is a constant westerly deflection of the needle. If the rods are placed in the opposite direction from their point of contact with the circle, similar easterly deflections will be produced.

The iron rod has been here used as an example, because the effects can be most simply shown thereby; but other forms of iron (240) are generally used in adjusting compasses, to produce the same effects. Hollow iron spheres are used with Sir William Thomson's compass. Their action is that of a rod of the length of the diameter of the sphere, always standing in the line of the earth's magnetic force, and magnetised thereby. In the figure, where *c* is the centre of the compass needle, it will be seen that the horizontal force of the spheres deflects it, and affects its pointing force, in the same manner as the iron rod in 242. When east and west of the centre, however, spheres diminish the directive force on the needle, more than the forms of iron commonly used.



Having briefly examined the means employed to counteract the ship's magnetic forces, the origin and effect of those forces, and the mode of applying the counteracting means, may now be considered.

244. An iron ship, in the course of construction, stands in the influence, or field as it is termed, of the earth's magnetism, and is consequently magnetised by induction. In north magnetic latitude, all upright iron structures, such as stern-post and frames, have positive magnetism in their lower ends, and negative magnetism in their upper ends. In south magnetic latitude, these conditions are reversed. In all latitudes, horizontal iron structures, such as beams and keel, have positive magnetism in their northern ends, and negative magnetism in their southern ends. The ship throughout is, in course of building, permeated with magnetism in the direction of the inducing force. Part of the magnetism thus acquired in building remains after the ship has been launched, causing a permanent magnetic force, in some direction in the ship.

This force tends to draw the north point of the compass towards that part of the ship which was south in building.

Besides this permanent magnetism, the ship, as she subsequently turns about with her head in different directions, takes up magnetism according to her varying positions. The amount of magnetism iron will thus receive by induction, within the limits of the change in the earth's force, varies as that force; the ends of beams, and other parts of the ship's structure, which are towards the north having positive magnetism, which changes and becomes negative when the direction of the ship's head is reversed. It is evident, however, that vertical iron will have magnetism which does not depend on the direction of the ship's head, but which will vary, in character and value, with the earth's vertical force only.

245. From these premises it will be seen, that there must be always a Constant force, and a Variable force, acting on the compass needle as the ship goes round. Therefore, if the direction and value of these forces are known, together with the law which governs the change in the variable force, the deviation of the compass could be found without swinging the ship. Generally, it is easier to deal with the deviation than with the forces which cause it; but a knowledge of the manner in which these forces act, facilitates very much the construction of a deviation table. Considering the commercial value of time, in all matters relating to shipping, this is a subject of no small importance.

246. It has been stated, that part of the magnetism acquired in building causes a constant force, in some direction, in the ship. The amount of deviation any force is capable of producing must decrease, as the force with which the needle points increases. Therefore, the deviation caused by the ship's permanent magnetism varies inversely as the earth's horizontal force.

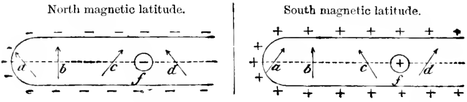
It is also clear, that, if the direction of the ship's permanent magnetic force is known, a permanent force by means of magnets (239) might be produced to counteract it; and if this magnetism of the ship, and of the magnets, were equally permanent, the adjustment would be perfect for all time and places.

The transient magnetism of vertical iron also causes a force which is constant in direction and value, as the ship goes round. This force, however, changes with change of place, as it depends on the earth's vertical force for its value. The liability of the needle to be deflected thereby varies inversely as the horizontal force. Therefore, the deviation caused by the transient magnetism of vertical iron will vary as,

$$\text{ver. force} \times \frac{1}{\text{hor. force}} = \text{tan. dip}$$

247. The following diagram will show how the compass is affected by the transient magnetism of vertical iron, and the manner in which Flinders' bar (241) counteracts that effect.

After Part of Ship's Upper Deck. Head East.



In north magnetic latitude, the upper part of the ship's frames having negative magnetism, a compass in the position (*a*) would have its north point drawn to the westward. In south magnetic latitude, it would be drawn to the eastward. It is certain that no fixed magnet would meet this change. A Flinders bar, however, might be placed before the compass, so that its magnetism would exactly counteract that of the stern frames. The magnetism of the bar would change, exactly as that of the stern frames, when the ship went into south magnetic magnitude.

At a position (*b*), generally rather more than one-third of the distance between the stern and the funnel (*f*), the magnetism of the upper part of the boilers and funnel counteracts that of the stern frames, so that no bar is required.

At the position (*c*), the bar would be required abaft the compass; at the position (*d*), before the compass.

The position (*b*), when not otherwise objectionable, is chosen for the position of the standard compass in the Royal Navy. The position (*d*), being more convenient, is commonly used in the Mercantile Navy.

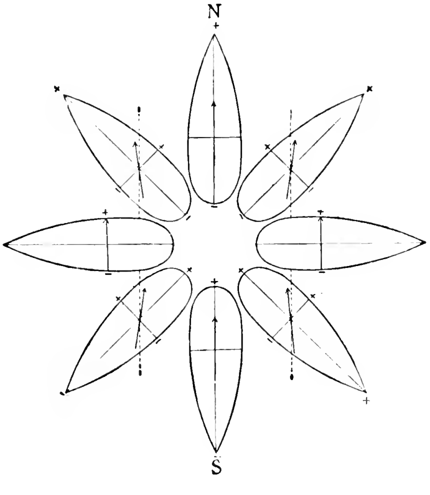
If a compass were placed out of the middle line, its north point would be drawn to the near side of the ship in north magnetic latitude, and repelled therefrom in south magnetic latitude. This effect would have its maximum value when the ship's head is north or south; and the Flinders bar must be towards the middle line, to counteract it.

248. The horizontal forces, from permanent magnetism and the transient magnetism of vertical iron, cause a deviation which is zero when the direction of the ship's head is such that the resultant of these forces is in the north and south line; and a maximum deviation when that resultant is in the east and west line. This deviation, from being easterly through one semicircle, and westerly through the other, is called the Semicircular Deviation.

In correcting the semicircular deviation, such magnets as are commonly used should not be brought nearer than twice their length to the compass needles. And Flinders' bar should not be so near to the compass needles, or correcting magnets, as to receive magnetism by induction from them.

249. When the semicircular deviation has been got rid of, by

the means shown, there remains the deviation caused by the variable force. This force comes from the transient magnetism of horizontal iron; or, from the transient magnetism induced by the earth's horizontal force, in iron in any position. It causes a deviation which has four equidistant zero points, and is alternately easterly and westerly, in the intervening quadrants. It is for this reason called Quadrantal Deviation. The following diagram will show how it is caused, and why it takes that form.



Let the figures in the diagram represent the upper deck of a ship, in the several positions, and the fore-and-aft and thwartship lines thereon represent the horizontal magnetic axes of the ship, passing through the centre of the compass. Considering the magnetism of these axes to be positive in the ends presented to the north, it will be seen that, with the ship's head north, there will be no deviation; with the head N.E., the thwartship magnetism tends to deflect the needle to the right, while the fore-and-aft magnetism tends to deflect it to the left. From the proximity of the poles of the thwartship magnetism, as compared with the poles of the fore-and-aft magnetism, the deviation is always easterly.

It is as well, however, for the student to recognise the possibility of its being westerly, as in the case of a very flat vessel, where the compass might be placed not much above the screw-shaft, or keel.

Following the vessel round in the several positions, it will be seen that there is a deviation, alternately easterly and westerly, having its zero points when the ship's head is on the cardinal points; and that there is always a diminution of the pointing force of the needle. No. 242 shows, that a quadrantal deviation of this kind could be corrected, and the pointing force of the needle increased, by placing iron on each side of the compass, directly athwartships.

The compass might be so placed, with reference to the iron about it, especially if it were out of the middle line of the ship, that the magnetic axes would be oblique in the ship. In that case, the zero points of the quadrantal deviation would not be at the cardinal points. No. 242 shows that any quadrantal deviation can be corrected, by placing iron beside the compass, at the same angle from the ship's head, as the zero points which have easterly quadrantal deviation on their left, are from the north point of the compass.

250. Besides the semicircular and quadrantal deviations, there is sometimes a residual deviation, which has the same value in whatever direction the ship's head may be, and is therefore called the Constant Deviation. No. 243 shows that if a compass were placed near iron, such as bulkheads, in somewhat the relative position of the corrector there shown, a positive or negative constant deviation might be caused, and that either one or the other can be corrected, by correctors placed tangentially.

251. Reverting to the force which is in some fixed direction in the ship, the deviation caused thereby must be the same in amount, but contrary in sign, when the ship's head is in opposite directions; or, when the deviation is small, in opposite directions by compass.

Looking at the cause of the variable force, whatever may be the position of iron about a compass, that force will be the same when the ship's head is in opposite directions. The deviation caused thereby will also be the same in amount, and have the same sign, when the semicircular deviation has been corrected, or is small.

These facts show how the deviation caused by the variable force may be separated from that caused by the constant force. Let the deviation on each point of the compass be tabulated in the following form:

Head	Deviation	Head	Deviation	Column I.	Column II.	Column III.
	° ′		° ′	° ′	° ′	° ′
North	0 0	South	8 0 E.	4 0 E.	0 05 W.	1 57 E.
N. b E.	4 20 E.	S. b W.	8 30 E.	6 25 E.	2 0 W.	2 12 E.
N.N.E.	6 40 E.	S.S.W.	8 30 E.	7 35 E.	3 35 W.	2 0 E.
N.E. b N.	8 50 E.	S.W. b S.	7 40 E.	8 15 E.	4 25 W.	1 55 E.
N.E.	10 0 E.	S.W.	6 0 E.	8 0 E.	4 05 W.	1 57 E.
N.E. b E.	10 20 E.	S.W. b W.	3 10 E.	6 45 E.	2 50 W.	1 57 E.
E.N.E.	9 50 E.	W.S.W.	0 20 W.	4 45 E.	0 40 W.	2 02 E.
E. b N.	8 10 E.	W. b S.	3 50 W.	2 10 E.	1 40 E.	1 55 E
East	7 0 E.	West	7 10 W.	0 05 W.		8(15 55 E.
E. b S.	5 40 E.	W. b W.	9 40 W.	2 0 W.		
E.S.E.	4 30 E.	W.N.W.	11 40 W.	3 35 W.	Constant deviation	2 0 E.
S.E.E.	3 40 E.	N.W. b W.	12 30 W.	4 25 W.		
S.E.	3 40 E.	N.W.	11 50 W.	4 05 W.		
S.E. b S.	4 0 E.	N.W. b N.	9 40 W.	2 50 W.		
S.S.E.	5 30 E.	N.N.W.	6 50 W.	0 40 W.		
S. b E.	6 50 E.	N. b W.	3 30 W.	1 40 E.		

Take half the sum of the deviations, on each pair of opposite points, and insert it, with its proper sign, in column I. From what has gone before, this must be the deviation caused by the variable force, on each of the two points. That is, on the north and south points, there is 4° easterly deviation, on N. b E. and S. b W., 6° 25′ E., on N.N.E. and S.S.W., 7° 35′ E., from that force. So the deviation caused thereby can be ascertained on every point of the compass.

To find how much of column I. has the same value on every point, bring up its lower half into column II. Insert half the sum of the values in columns I. and II., with its proper sign, in column III. Each value in this column will be that of the mean of the deviation on four points 90° apart, and should be equal to each other, and to the mean constant deviation 2° 0′ E.

The deviation in column I., made up of the quadrantal and the constant deviations, has the same value in all parts of the world. Because, the disturbing force and the pointing force of the needle vary together, both depending on the earth's horizontal force. It also changes but little with time, losing about ·05 of its value in a year, owing to the fact that iron slowly loses its capacity for receiving magnetism by induction. It may be worth noting here, that this quantity has nearly the same value, at compasses similarly placed, in ships nearly alike.

The correction by soft iron is also perfect for all time and places, if the magnetism of the correctors is derived from the earth's force only; but when the correctors are placed so near to compass needles, as to receive magnetism by induction from them, though it adds to their power as correctors, the correction is to that extent imperfect, the correctors having less effect when the horizontal force is increased. The soft iron correctors should on no account be less than the length of the needles, from their ends.

252. When a compass is placed on the upper deck, in the middle line of the ship, with the iron in about the same relative position on each side of it, and the usual height for taking bearings, the maximum quadrantal deviation is about 6° in a new iron ship. Its zero points are at the cardinal points, and there is no constant deviation. In compasses placed in very unfavourable positions, the constant deviation has amounted to 12°, and the quadrantal deviation to 24°, and possibly more.

It is not customary to correct the constant deviation by soft iron, as it occurs generally only in compasses not required for taking bearings. To meet it, the binnacle, or the compass in the binnacle, or the lubber-line itself, is so placed, that it points the value of the constant deviation, on the starboard bow, when positive, and on the port bow when negative. Thus, a course steered by a compass, having the lubber-line so placed, is unaffected by the constant deviation.

If the quadrantal and constant deviations were not corrected, or were only partially corrected, column I. (251), the sum of their values might be tabulated on each point of the compass, whenever opportunities occur of swinging the ship completely round. Bearing in mind what has been said (No. 251), this quantity should soon become very exactly known, leaving only the semicircular deviation to be ascertained.

253. The horizontal forces causing the semicircular deviation, are best considered as resolved in the fore-and-aft and in the athwartship directions. The fore-and-aft force causes a maximum deviation, when the ship's head is east or west. The athwartship force causes a maximum deviation, when the head is north or south. Looking at the deviation table (No. 251), and allowing for the value in column I., it is evident that in this case there is a force towards the ship's head, capable of producing a maximum deviation of 7° 5′, and that there is a force towards the ship's port side, capable of producing a deviation of 4°. Therefore, to adjust this compass, a force must be produced by magnets, or Flinders' bar, or both, towards the stern, leaving 5′ westerly deviation on the east and west points; and towards the starboard side, leaving 4° easterly deviation on the north and south points. These residual quantities must be corrected by the means already explained, Nos. 249, 250.

Hence the law for correcting the semicircular deviation. Make the deviation zero on any two adjacent cardinal points. If it is known, or, from the position of the iron about the compass, suspected, that there is deviation on those points from the variable force, then the ship's head must be placed on the opposite cardinal points also, and half the deviation found thereon taken out.

254. The question naturally arises, as to how much of the semicircular deviation should be taken out by magnets, and how

much by Flinders' bar. At first, there is no other guide than the position of the compass (No. 247); but when a ship has gone into positions where there is much change in dip and horizontal force, a better judgment can be formed. At the magnetic equator, there can be no transient magnetism in vertical iron; all the semicircular deviation there found, must be caused by the ship's permanent force. Hence if, near the magnetic equator, the semicircular deviation be corrected by magnets, any deviation subsequently found, arising from change of place, should be corrected by Flinders' bar.

From the fact (No. 246) that one part of the semicircular deviation varies inversely as the horizontal force, and the other part as the tangent of the dip, the value of each of these parts can by ascertained, if the deviation is observed in two magnetic latitudes.

Example.—The steamship *Scotia*, having a standard compass in position *d* (No. 247), corrected by magnets in the Thames, soon after, in latitude 30° S., longitude 16° E., found 12° easterly deviation on the east point, and 10° westerly on the west point. How much of the deviation on those points should be corrected by Flinders' bar?

From map 232, and table 233:—

Thames, dip $67\frac{1}{2}°$; Nat. tan. of dip 2·42; Hor. force ·48.
Lat. 30° S., Lon. 16° E. } dip – 51°, Nat. tan. of dip – 1·24; Hor. force ·54.

Let P = the deviation from permanent magnetism,
and T = the deviation from transient magnetism of vertical iron.

(1) Thames . $\frac{P}{\cdot 48} + T \times 2\cdot 42 = 0.$

(2) Lat. 30° S., Lon. 16° E. } $\frac{P}{\cdot 54} + T \times -1\cdot 24 = 11°$ semicircular on east point.

From (1) $P = -1\cdot 16\ T$,
substituting in (2) $-3\cdot 39\ T = 11°$ semicircular on east point.

Therefore $T = -\frac{11°}{3\cdot 39} = -3\cdot 25°$ on east point.

In the Thames . $-3\cdot 25° \times 2\cdot 42$ (the tan. of dip) $= -7\frac{3}{4}°$.
Lat. 30° S., Lon. 16° E. $-3\cdot 25° \times -1\cdot 24$ (the tan. of dip) $= 4°$.

Therefore, a Flinders bar should be placed before the compass, capable of deflecting the needle $7\frac{3}{4}°$ in the Thames, and 4° at the southern position. These deflections, from the magnetism of the bar, will be in opposite directions, and will exactly correct the deviation caused by the transient magnetism of vertical iron. Clearly, the magnetism of the funnel, in this case, draws the north point of the needle aft, in north magnetic latitude; and forward, in south magnetic latitude. A convenient form of Flinders' bar is fitted to the binnacle of Sir Wm. Thomson's compass.

255. The value of the semicircular deviation, on the east or west point, is a key to the value of the deviation caused by the

force in the fore-and-aft line, on every point of the compass. Similarly, the value of the semicircular deviation, on the north or south point, is a key to the value of the deviation caused by the force in the thwartship line, on every point of the compass. As the deviation on any point is made up of that caused by the forces in these two directions, added to that caused by the variable force, it is evident, that if the latter be known (No. 252), and the semicircular deviation be ascertained on two adjacent cardinal points, the deviation table can be completed.

When the semicircular deviation is small, the following table will be useful for that purpose :—

Semicircular deviation on any cardinal point	Semicircular deviation caused by the same force, on each point, reckoned right and left from that cardinal point, through the adjacent quadrants							
	1st	2nd	3rd	4th	5th	6th	7th	8th
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1	0 59	0 55	0 50	0 42	0 33	0 23	0 12	0 0
2	1 58	1 51	1 40	1 25	1 7	0 46	0 23	0 0
3	2 57	2 46	2 30	2 7	1 40	1 9	0 35	0 0
4	3 55	3 42	3 20	2 50	2 13	1 32	0 47	0 0
5	4 54	4 37	4 9	3 32	2 47	1 55	0 59	0 0
6	5 53	5 33	4 59	4 15	3 20	2 18	1 10	0 0
7	6 52	6 28	5 49	4 57	3 53	2 41	1 22	0 0
8	7 51	7 24	6 39	5 39	4 27	3 4	1 34	0 0
9	8 50	8 19	7 29	6 22	5 00	3 27	1 45	0 0
10	9 48	9 14	8 19	7 4	5 33	3 50	1 57	0 0

Example.—The deviation (table 251) having been observed to be 8° 0′ E. on the south point, and 7° 10′ W. on the west point, what is the deviation on the N.W. b W. point?

The semicircular deviation on the south point, allowing for the value in column I., must be 4° E. It is therefore 4° W. on the north point, and, from the above table, 2° 13′ W. on N.W. b W., five points from north.

The semicircular deviation on the west point must be 7° 5′ W., it is therefore 5° 53′ W. on N.W. b W., three points from west. Therefore the whole deviation on N.W. b W. must be
2° 13′ W. + 5° 53′ W. + 4° 25′ W. (the value in col. I.) = 12° 31′ W.

The semicircular deviation being the same in amount, with contrary signs, on opposite points, the deviation on S.E. b E. is 8° 6′ E. + 4° 25′ W. = 3° 41′ E. In the same manner, the deviation on every point of the compass can be estimated.

There may be circumstances where it would be convenient to ascertain the position of the correctors necessary to apply to a compass, by measuring hor. force (234). The most simple way of looking at the problem is, to consider a ship lying with her head in any known magnetic direction. By placing a horizontal magnet at right angles to the compass needle, and so keeping it, the needle may be made to stand in the direction of the magnetic meridian. By placing another horizontal magnet in the line of the magnetic meridian, the force with which the needle points may be made equal to the force on shore. Thus, all the forces due to the ship's magnetism, may be counteracted with the ship's head in the one direction. But when the ship's head is moved round, the needle will move away from the magnetic meridian, by reason of the change in the variable force. When the head is in the opposite direction, the deviation will be nearly equal to twice that caused by the variable force, and the needle will point with a force which will differ from the horizontal force on shore, by twice the value of the component of the variable force in the direction of the needle, nearly.

Therefore, to counteract the force which causes the semicircular deviation, the distance of the magnets from the card must be so adjusted, that the needle points with the mean value of the force found with the ship's head in the two directions, and with half the deviation found in the second position.

Another way of dealing with the problem is suggested by considering the following facts. If the force with which the needle points is the same when the ship's head is east and west, there can be no constant force in the athwartship line. If it is the same when the ship's head is north and south, there can be no constant force in the fore-and-aft line. Therefore, when these conditions are fulfilled, there can be no semicircular deviation. Further, if the force is the same on the four cardinal points, there can be no quadrantal deviation.

Working by force is a more delicate operation than working by bearings, and, under the circumstances in which the seaman has generally to work, is scarcely capable of the same degree of accuracy. If advantage be taken of the known direction of docks, wharves, transit and other lines, there will be few occasions where it will be necessary to have recourse to measuring force. But with the two methods available, there should be no detention of ships in port for the purpose of compass adjustment.

256. Hitherto the effects of the vertical component of the ship's forces have not been considered, because a vertical force cannot deflect the compass-needle, right or left. But when a ship heels, a force previously vertical may be no longer so, and the position of the iron about a compass may be so changed, as to introduce a new magnetic force. The deviation, caused by this change in a ship's magnetic forces, is called the Heeling Error. To estimate or correct the heeling error with theoretical accuracy is not an easy problem; especially in certain positions in a ship, and with the semicircular deviation uncorrected. The following remarks must be considered as applying to a compass, in such a position as is usually selected for a standard compass, and having the semicircular deviation corrected. At a compass so situated, there will be a force upwards or downwards in the ship, caused by per-

manent magnetism. The value of this force will depend, mainly, upon the direction in which the ship was built, and the position of the compass in the fore-and-aft line. It may be counteracted by a magnet placed end on (239), and vertically below the centre of the compass. If it is not counteracted, it will, by coming partly on one side when the ship heels, draw the north point of the compass to one side or the other.

There will also be a force upwards or downwards in the ship, from the transient magnetism of vertical iron, depending for its value on the earth's vertical force, of which it is a constant fraction. This force, in north magnetic latitude, is that of a negative pole under the compass, changing to positive in south magnetic latitude, drawing the north point of the needle to the high side of the ship in the former case, and to the low side in the latter. This force evidently should not be counteracted by a fixed magnet, but by a bar of soft iron, having, in north magnetic latitude, negative magnetism in the end nearest to, and above, the compass. ·05 of the earth's vertical force is about a mean value of the vertical force caused by induction therefrom; therefore, in correcting the heeling error by a vertical magnet, the vertical force of the earth and ship should be brought to about 1·05 of the earth's vertical force, wherever the ship may be.

Sometimes the position of the funnel, or an iron mast, may be such, that its vertical transient magnetism counteracts that of the ship; this will probably be the case in a compass in such a position as *d* (247). Or it may be counteracted by putting the upper end of the Flinders bar, where one is used, above the level of the compass.

Looking at the magnetic condition of athwartship iron, such as beams, passing under the compass, when, from the ship heeling, it departs from the horizontal position, it is evident that the higher ends will have negative magnetism, drawing the north point of the compass-needle to the high side of the ship in north magnetic latitude. The reverse of this takes place in south magnetic latitude, therefore this force should not be counteracted by a fixed magnet.

If a soft iron bar were placed horizontally athwartship, on each side of the compass, the magnetism induced therein would, if they were of suitable size and distance from the compass needle, exactly counteract the magnetism induced in the athwartship iron of the ship. This condition is nearly fulfilled by soft iron so placed as to correct the quadrantal deviation, so that no separate corrector is required for this part of the heeling error.

Because the transient magnetism of horizontal fore-and-aft iron, below the compass, causes a vertical force which is zero when the ship's head is east or west, it is desirable to correct the heeling error when the ship's head is nearly on those points. Then, if the quadrantal deviation is corrected, and the vertical force brought by a magnet to the same value as, or a little more than, the vertical force on shore, the heeling error will be practically corrected.

The forces which cause the heeling error, by drawing the north end of the needle to one side or the other, must have their maximum effect when the ship's head is north or south. When the ship is rolling, the north end of the needle being drawn to each side alternately, causes the card to be unsteady. This disturbance of the compass-card has probably been more trouble to the navigator, than the error produced by heel.

Thus, in dealing with compass deviation, there are two distinct problems: one, to ascertain its amount; the other, to get rid of it altogether. At first sight, one or the other of these processes appears unnecessary, and in the early days of iron ships some thought that, with a table of deviation, there was no need for correctors; others that, if the compass were corrected, there was no need for a table of deviation. Experience has long since shown that neither of these views was correct. Many iron ships could not be navigated unless the compass was, at least, partly corrected. On the other hand, though compasses are frequently so well adjusted as to be without deviation, there are small changes subsequently which cannot be safely disregarded, rendering a deviation table necessary.

Changes which are gradual can be met by the ordinary daily observations, which should never be omitted; but there are some changes which are sudden, against which the seaman must be on his guard. If a ship has been steering for some time on one course, she will acquire negative magnetism in the part of the ship towards the south. On first altering course, the north point of the compass is likely to be drawn, for a short time, towards that part of the ship which was previously south. This is especially the case in changing from courses near east or west to those near north or south. Of course, the same effects follow when a ship has been some time in dock.

Thin iron structures, such as funnels, funnel casing, or ventilating cowls, are liable to change their magnetic state from strains or concussion, and so affect the deviation of a compass placed near. Any shock or strain which causes iron to vibrate or bend, and so cause movement in its particles, facilitates magnetic change.

With the introduction of electric lighting on board ship, came a new form of compass disturbance. The magnetism of the large electro-magnets, in the dynamos at present used, may disturb a compass at the distance of sixty feet. Also, circling round the wires conducting electricity, and at right angles to their direction, is a magnetic force, going in one direction round the wire conducting the direct current, and in the opposite direction round the wire conducting the return current. Thus these forces counteract each other when the conducting wires are together, but when they are separated cause a proportional disturbance to the compass.

The maximum value of this disturbance, for any speed of the dynamo, is apparent directly the dynamo is started at that speed. So, by starting and stopping the dynamo, with the ship's head on two adjacent cardinal points, and noting the effects, the value of the disturbance on every point of the compass can be ascertained. Table 255 will be useful for this purpose.

257. A method of measuring the effects of a ship's magnetic forces, in causing deviation, was introduced by the late Mr. Archibald Smith. He found that the deviation could be expressed, as in the following equation:—

$$\text{Deviation with ship's head on any point} = A + B \cdot \sin \zeta' + C \cdot \cos \zeta' + D \cdot \sin 2\zeta' + E \cdot \cos 2\zeta'.$$

The factors A, B, C, D, E, are called coefficients, and ζ' is the direction of the ship's head by compass, reckoned round the circle to the right. Therefore, in dealing with the equation, the seaman, who generally has to deal only with angles not greater than a right angle, must consider the sign of the direction of the head, as well as that of the coefficient, in each term.

A, the first term in the expression, is the value of the constant deviation (250). It may be found by taking the sum of the deviation on the four cardinal points, and dividing it by four.

B is the maximum value of the deviation caused by the force in the fore-and-aft line (253). It is + when the force is towards the ship's head, and − when towards the stern. It may be found by adding to the deviation on the east point, the deviation on the west point with its sign changed, and taking half that sum. Any constant force in the fore-and-aft line, which causes this deviation, must cause a deviation $= B \cdot \sin \zeta'$, the second term of the expression, on every point of the compass.

C is the maximum value of the deviation caused by the force in the athwartship line (253). It is + when the force is towards the ship's starboard side, and − when towards the port side. It may be found by adding to the deviation on the north point, the deviation on the south point with its sign changed, and taking half that sum. Any constant force in the athwartship line, which causes this deviation, must cause a deviation $= C \cdot \cos \zeta'$, the third term in the expression, on every point of the compass.

D is the mean value of the deviation on the inter-cardinal points, caused by the variable force (249). It may be found by adding to the deviation on the N.E. and S.W. points, the deviation on the S.E. and N.W. points with the sign changed, and taking the fourth part of that sum. A force varying regularly, and causing this deviation, must cause a deviation $= D \cdot \sin 2\zeta'$, the fourth term of the expression, on every point of the compass.

E is the mean value of the deviation on the cardinal points, caused by the variable force (249). It may be found by adding to the deviation on the north and south points, the deviation on the east and west points with the sign changed, and taking the fourth part of that sum. A force varying regularly, and causing this deviation, must cause a deviation $= \mathrm{E} \cdot \cos 2\zeta'$, the fifth term of the expression, on every point of the compass. The existence of the E shows that the axes are oblique (249).

It is obvious that the foregoing statement of the effect of the forces in causing deviation is true only when each force is the only disturbing force on the needle; it is true enough when those forces are small: in that case the resulting deviation is also small, and the sum of the five terms is equal thereto; when the deviation is large, the coefficients must be determined with more exactness. With such deviations as are usually found, since the general adoption of compass adjustment, the method here given is sufficiently exact.

The student must not consider the coefficients as forces, or as in any way causing the deviation; they merely measure it, with more or less exactness. And by their means the parts of the deviation can be particularised, in speaking and in writing, and a record of its value kept in five terms, of which two are generally zero. Excepting for this purpose, the treatment of the subject by coefficients, especially laborious methods of determining their exact values, and of deriving the ship's magnetic forces therefrom, has never been greatly esteemed by navigators.

258. Professor Airy made use of the terms Red and Blue, to indicate the two kinds or states of magnetism, of the north and south ends of the compass needle respectively. These terms have been of great use, especially in making clear, by coloured diagrams, the distribution of magnetism in iron ships. The terms positive and negative have been used in this chapter, being in accord with the terms used in the kindred science of electricity, which is daily becoming of more importance to seamen.*

The subject of compass deviation and adjustment was thoroughly investigated by a body of scientific men, shipowners, and others, interested in the subject, called the Liverpool Compass Committee. The results of their labours were published, in language intelligible to seamen, in three most valuable reports to the Board of Trade, 1856, 1857, 1861.

* Professor (now Sir) George Biddell Airy, K.C.B., has lived to see his accurate and thoroughly practical method of adjusting compasses, devised half a century ago, overcome all opposition, and be now, and for many years past, universally adopted. He has in other ways furthered the science of navigation, but in facilitating the navigation of iron ships he is pre-eminent.

The following Notes are the result of recent theory and experience. The numbers refer to Articles in the present edition.

Art. 215. The method of suspension by india-rubber has been discontinued, owing to its rapid deterioration when exposed to heat and wet.

216. In Lord Kelvin's (Thomson) compasses the outer graduation of the numerals is inverted in the Navigational or Standard Compass to enable the card to be read direct with the azimuth mirror. The average period of a Thomson's card varies from thirty seconds for a ten-inch card to thirteen and a half seconds for a four-inch one.

219. The Variation at Greenwich was (1899) 16° 34′ westerly, decreasing 7′ annually.

220. The simultaneous appearance of auroras and disturbances of the magnetic needle (magnetic storms) are manifestations of the same cause. The late Father Secchi held that thunderstorms exercised a perceptible influence on the magnetic needle. The disturbing element of land on the compass needle is recognised to be submarine. Theory confirmed by experience show that if the rocks are the upper extremities of a ridge in north magnetic latitudes they would attract and in southern repel, the red (paragraph 239) end of a compass needle.

223. The prefix correct to true, magnetic and compass courses is being discontinued, a true course is a compass one corrected for variation and deviation; a magnetic course, the same corrected for deviation, and a compass course, one uncorrected for variation and deviation.

232. The Dip of the needle at Greenwich was (1899) 67° 10′, decreasing 1′·7 annually.

237. The expression, "magnetism by induction from the earth" is seldom used; the magnetism of both earth and soft iron are produced by the same lines of magnetic force.

239. To avoid ambiguity, the pole of a magnet that attracts the north-seeking end of the needle is called blue and the repelling one red, bearing in mind the pole in the north end of a compass needle is a true south pole, and that in the south end of a compass needle is a true north pole.

244. Read paragraph at 237. Gaussin error is often developed by magnetic induction in a ship's iron beams, more especially when proceeding east and west; in fast Atlantic liners a Gaussin error of 8° to 10° is not unusual during a voyage across the Atlantic.

249. A compass is usually corrected in the following order: the quadrantal error, the heeling error, and lastly the semi-circular error.

256. In merchant vessels arrangements are usually made to place

the navigational compass beyond the magnetic field of the dynamo, but the necessary arrangements in a man-of-war may prevent this being carried out. A compass if within the magnetic field of a dynamo will be disturbed, the error altering with change of azimuth.*

In the general type of dynamo supplied to H.M. ships, designed for 80 volts at the terminals, the minimum distance of a compass should be 60 feet from a 300-ampère machine, increased to 70 feet from a 400-ampère one. A 600-ampère machine being armour-clad and multipolar produces no disturbance on a compass 15 feet away. In the "Destroyers" the correction is made by an electro-magnet at the foot of the compass pedestal, with its poles reversed to those of the dynamo; in second class cruisers (*Apollo* class) by exciting the shunt coils of both dynamos, when only one is in use, the resulting disturbances are neutralised, provided the poles of the dynamos are symmetrical to the middle line.

In the electric lighting of a compass, the current is usually conveyed to a 16 c.p. lamp by a twin cable, protected by phosphor-bronze braiding. The best position is to place the lamp vertically above the axis of the compass needle; occasionally a disturbance arises from the inductive effect due to the current in the filament of the lamp itself.

A small electric light (half-candle power) is found useful for star azimuths at night or if fitted to a sextant for stellar observations.

* For detailed information see *The Mariner's Compass in an Iron Ship*, by Captain J. Whitly Dixon, R.N., sold by J. D. Potter, 145 Minories, London, E.

II. The Log and Glasses.

1. *The Log.*

259. The log consists of the *log-ship* and *line*. The log-ship is a thin wooden quadrant, of about five inches radius; the circular edge is loaded with lead, to make it float upright, and at each end is a hole. The inner end of the log-line is fastened to a reel, the other is rove through the log-ship and knotted; and a piece of about eight inches of the same line is spliced into it at this distance from the log-ship, having at the other end a peg of wood, or bone, which, when the log is hove, is pressed firmly into the unoccupied hole.

At ten or twelve fathoms from the log-ship a bit of buntin rag is placed, to mark off a sufficient quantity of line, called *stray-line*, to let the log go clear of the ship before the time is counted.

260. The log-line is divided into equal portions, called *knots*, at each of which a bit of string, with the number of knots upon it, is put through the strands.

The length of a knot depends on the number of seconds which the glasses measure, and is thus determined:

The No. of feet in 1 knot : No. of feet in 1 mile : : No. of seconds of the glass : 3600 (the No. of seconds in an hour).

The nautical mile being about 6080 feet,* we have, for the glass of 30 seconds, the knot $= \frac{6080 \times 30}{3600} = 50{\cdot}7$ feet, or 50 feet 8 inches, for the glass of 28 seconds, the knot $= \frac{6080 \times 28}{3600} = 47{\cdot}3$ inches, or 47 feet 4 inches; and so for any other glass.

261. The knot is supposed to be divided into eight equal parts, or fathoms (which they are very nearly). In the Royal Navy the knot is divided into tenths and the even fathoms only are reckoned, for the convenience of adding up the distance on the log-board.†

262. The log-line should be repeatedly examined, by comparing each knot with the distance between the nails, which are (or should be) placed on the deck for this purpose, at the proper distance. The line should be wet whenever it is required thus to remeasure it, or to verify the marks.

* The Geographical Mile is generally defined to be the length of a minute of arc in the earth's equator; but the Nautical Mile as defined by hydrographers is the length of a minute of the meridian, and is slightly different for every different latitude. (See Table 64A.) It is equal to a minute of arc in a circle, whose radius is the radius of the curvature of the meridian, at the latitude of the place.

† It is, of course, more systematic to divide the knot or mile into tenths, as in the Traverse Table, instead of eighths; but single tenths and fathoms may be used for each other without sensible error.

263. As the manner of heaving the log must be learned at sea, it is only necessary to remark, for reference, that the line is to be faked in the hand, not coiled; that the log-ship is to be thrown out well to leeward to clear the eddies near the wake, and in such a manner that it may enter the water perpendicularly, and not fall flat upon it; and that before a heavy sea the line should be paid out rapidly when the stern is rising, but when the stern is falling, as this motion slacks the line, the reel should be retarded.

264. (2) *Massey's Log* shews the distance actually gone by the ship through the water, by means of the revolutions of a fly towed astern, which are registered on a dial-plate. This log is highly approved in practice.*

265. When the water is shoal, and the set of the tides or current much affected by the irregularity of the channel, or other causes; and when, at the same time, either the ship is altogether out of sight of land, or the shore presents no distinct objects by which to fix her position, recourse may be had to the *ground log*. This is a small lead, with a line divided like the log-line; the lead remaining fixed at the bottom, the line exhibits the effect of the combined motion of the ship through the water, and that of the water itself, or the current; and therefore the course (by compass) and distance made good are obtained at once.†

Caution.—Logs, whether patent or common, are unsatisfactory instruments in these days of high speed. No patent log yet invented will stand the wear and tear of a fast ship for any length of time. To avoid this wear and tear they should be used only when coasting or in with the land. They will tell a different story in a head sea to what they do in a following sea. In slow steamers and sailing ships they are naturally more reliable. Still, logs must be used; but it must be remembered they are beset with *impediments*, and their indications must not be *implicitly* trusted in critical times.

By practice, seamen learn to estimate the rate of progress of the ship closely by the number of revolutions in a given time made by the engines; but this is only speed through the *water*; the sailor has to consider carefully what that *unstable* element has *also* been doing.‡

Further, though ships may now better preserve a given course, and the distance run may be estimated more accurately than formerly, there are in modern iron ships elements of uncertainty about D.R. which still makes it perilous to close the land unless there are means of knowing with some certainty the ship's proximity thereto, especially where land has a bad reputation, as Ushant, C. Finisterre, C. Guardafui, Mocha I. in South America, &c.

* Other logs on this principle have since been invented and are in common use: notably, Walker's taffrail log. They should be well oiled, and stowed away clean.

† In numerous passages up and down the river Plate, where the above circumstances concur, Captain Gordon T. Falcon, in 1818–20 made constant use of this log.

‡ *See* Admiralty Current Charts, Tide Tables, and Sailing Directions, Nos. 951, 952.

266. (3) *The Glasses.*—The long glass runs out in 30ˢ or in 28ˢ; the short glass runs out in half the time of the long one.

When the ship goes more than five knots, the short glass is used, and the number of knots shewn is doubled.

267. The sand-glasses should frequently be examined by a seconds watch, as in damp weather they are often retarded, and sometimes hang altogether. One end is stopped with a cork, which is taken out to dry the sand, or to change its quantity.

268. When either the line or the glass is faulty, or when a line and glass not duly proportioned to each other are employed, the distance run is found as follows:—The number of feet in 1^h is to the number of feet run out in an observed number of seconds, as 3600 (seconds in an hour) are to the observed number of seconds.

Ex. Suppose 190 feet of line are run out in 22^s: required the rate.

The number of feet run out in 1^h : 190 :: 3600^s : 22^s; hence the number of feet $= \frac{190 \times 3600}{22} = 31090$ feet; which, divided by 6000 (as near enough), gives 5·2 miles.

CHAPTER III.

THE SAILINGS.

I. PLANE SAILING, WITH TRAVERSE, CURRENT, AND WINDWARD SAILINGS. II. PARALLEL SAILING, WITH MIDDLE LATITUDE, AND MERCATOR'S SAILINGS. III. GREAT CIRCLE SAILING.

269. IN considering the place of a ship at sea, with reference to any other place which she has left, or to which she is bound, these five things are involved: the Course, Distance, Difference of Latitude, Departure, and Difference of Longitude.

270. In practice these two general questions occur.

1st. The course and distance from one place in given latitude and longitude to another are given, and it is required to find the latitude and longitude of the other place.

2d. The latitudes and longitudes of two places are given, and it is required to find the course and distance from one to the other.

The methods of solution, that is, the rules of calculation, by which the answers to such questions are obtained, are commonly termed SAILINGS.

I. PLANE SAILING.

271. In Plane Sailing, as the term implies, the path of the ship is supposed to be described on a plane surface.

If the ship sails 1 mile on a given course, she makes a certain D. lat. and Dep.; in sailing a second mile, on the same course, she makes good the same D. lat. and Dep. as before. Thus the D. lat. and Dep. for 2 miles of Dist. are twice those for 1 mile; for 3 miles of Dist. they are three times those for 1 mile, and so on; that is, the total D. lat. and Dep. made good are proportional to the Dist. on the sphere as they would be on a plane. Plane Sailing, accordingly, treats of the relations of the Course, Dist., D. lat., and Dep., and applies to right-angled triangles generally.

But each mile of Dep. which the ship makes good corresponds to a Diff. of Long. which is different according to the latitude in which the ship moves (Note, p. 58), that is, there is no *constant proportion* between the Dep. and Diff. Long. in two different latitudes, and therefore a question in which Diff. Long. is concerned is not within the province of Plane Sailing, except the case in which the ship is on or near the equator, where Dep. and D. Long. are the same thing.

272. (1.) The proportions, No. 162, p. 46, as adapted to the figures, No. 200, p. 59 (or to the third figure of No. 163, where the course is the angle A B C), give the proportions or *canons*, as they are called, of Plane Sailing. We employ the following:

Dist. : Dep. :: rad. (= 1) : sin. Co.,	whence,	$\text{Dep.} = \text{Dist.} \times \sin. \text{Co.}$	(1.)
Dist. : D. Lat. :: 1 : cos. Co.,		$\text{D. Lat.} = \text{Dist.} \times \cos. \text{Co.}$	(2.)
D. Lat. : Dep. :: 1 : tan. Co.,		$\text{Dep.} = \text{D. Lat.} \times \tan. \text{Co.}$	(3.)
		and $\tan. \text{Co.} = \dfrac{\text{Dep.}}{\text{D. Lat.}}$	(4.)
D. Lat. : Dist. :: 1 : sec. Co.,		$\text{Dist.} = \text{D. Lat.} \times \sec. \text{Co.}$	(5.)
		and $\sec. \text{Co.} = \dfrac{\text{Dist.}}{\text{D. Lat.}}$	(6.)

(2.) These equations put into logarithms by the rules Nos. 64 and 65, p. 20, become

Log. Dep.	=	log. Dist. + log. sin. Co. − 10	(1.)
Log. D. Lat.	=	log. Dist. + log. cos. Co. − 10	(2.)
Log. Dep.	=	log. D. Lat. + log tan. Co. − 10	(3.)
Log. tan. Co.	=	log. Dep. + 10 − log. D. Lat.	(4.)
Log. Dist.	=	log. D. Lat. + log. sec. Co. − 10	(5.)
Log. sec. Co.	=	log. Dist. + 10 − log. D. Lat.	(6.)

Which logarithmic equations contain the rules employed.

On ordinary occasions four places are enough.

Case I. Given the course and distance, to find the difference of latitude and departure.

Ex. I. A ship sails N.W. by N. 03 miles from lat. 49° 30′ N.; find the D. Lat. and Dep. and also the Lat. in.

273. *By Inspection.* Open Table 2 at 3 Points,* and against the Dist. 103 stand D. Lat. 85·6 and Dep. 57·2.

Then 85·6 or 1° 25′·6 added to 49° 30′ gives Lat. in 50° 55′·6 N.

* Whenever the course is given in points or divisions of a point, it must be turned into degrees (213) before entering Traverse Table 1.

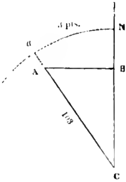
274. *By Computation.* (1.) For the D. Lat. To the log. cos. of the Course (Table 68) add the log. of the Dist. (Table 64); the sum (rejecting 10 from the index) is the log. of the D. Lat.

(2.) For the Dep. To the log. sine of the Course add the log. of the Dist.; the sum (rejecting 10) is the log. of the Dep.

Ex. above. Course 3 points, Dist. 103.

3 points, or 33° 45′	log cos 9·9198	Course 33° 45	log. sin. 9·7447
Dist. 103	log. 2·0128	Dist. 103	log. 2·0128
D. Lat. 85·6	log. 1·9326	Dep. 57·2	log. 1·7575
(This is the Canon (2.) in No. 272.)		(This is the Canon (1.) in No. 272)	

275. *By Construction.* Draw a line C N towards the north for the meridian. From the centre C, with the chord of 60° as radius, describe an arc on the west side of C N, and lay off the chord of three points, or 33°¾ to *a* (No. 107). Through *a* draw C*a*, this gives the angle N C *a* equal to the Course, or three points; lay off from a scale of equal parts C A equal to the Dist. 103; draw A B perpendicular to C N, then C B will shew on the same scale the D. Lat. 85·6, and A B the Dep. 57·2.



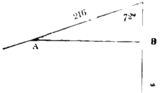
Ex. 2 A ship sails S. 72° W. 216 miles from lat. 14° 11′ N.: required the D Lat. and Dep., and also the Lat. in.

By Inspection. The Course 72° and Dist. 216 give D. Lat. 66·7 and Dep. 205·4. Then 66·7, or 1° 6′·7, subtracted from 14° 11′ N. leaves Lat. in 13° 4′·3 N.

By Computation.

Course 72°	log. cos. 9·4900	Course 72°	log. sin. 9·9782
Dist. 216	log. 2·3345	Dist. 216	log. 2·3345
D. Lat. 66·7	log. 1·8245	Dep. 205·4	log. 2·3127

By Construction. Draw a line C S to the southward for the meridian. By the chord of 60° lay off the arc 72° to the westward, and draw C A equal to 216; draw A B perpendicular to C S, then C B is the D. Lat. 66·7, and A B the Dep. 205·4.



These two examples of construction are sufficient for all varieties of Case I. When the course is to the eastward, C A is drawn on the right side of the meridian C N or C S instead of the left side.

Case II. Given the course and difference of latitude, to find the distance and the departure.

Ex. 1. A ship sailing W.S.W. makes 47 miles D. Lat.: find the Dist. run and the Dep.

276. *By Inspection.* Enter Table 1 with the Course 6 points look in the D. Lat. column for 47; the nearest to 47 is 47·1, against which stand the Dist. 123 and Dep. 113·6.

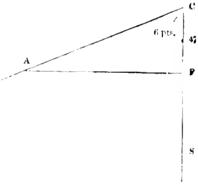
The Lat. of the ship is, from the nature of the case, already given.

277. *By Computation.* (1.) For the Dist. To the log. sec. of the Course add the log. of the D. Lat.; the sum (rejecting 10) is the log. of the Dist.

(2.) For the Dep. To the log. tan. of the Course add the log. of the D. Lat.; the sum (rejecting 10) is the log. of the Dep.

6 points, or 67° 30′	log. sec. 0·4172		Course 67° 30′	log. tan. 0·3828	
D. Lat. 47	log. 1·6721		D. Lat. 47	log. 1·6721	
Dist. 122·8	log. 2·0893		Dep. 113·5	log. 2·0549	
(This is the Canon (5.) in No. 272.)			(This is the Canon (3.) in No. 272.)		

278. *By Construction.* Draw the meridian line C S; lay off the course, or angle S C A, 6 points (No. 107); from C lay off C B the D. Lat. 47; draw B A perpendicular to C S, then C A is the Dist. and A B the Dep.



This example will suffice for all varieties of Case II. When the course is to the northward, C N is drawn upwards instead of C S downwards; and when the course is to the eastward, C A is to be drawn on the right side of the meridian instead of the left side.

Ex. 2. A ship sails N. 54° E. and makes 119 miles D. Lat.: required the Distance run and the Departure.

By Inspection. Course 54° in Table 1, and D. Lat. 119·3, give the Dist. 203 and Dep. 164·2, nearly enough in practice.

Case III. Given the difference of latitude and departure, to find the course and distance.

Ex. A ship makes 91 miles northing and 34·7 Dep. (easting): find her Course and Distance.

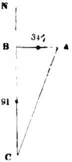
279. *By Inspection.* Look in Table 1 for 91 in the D. Lat. column, and 34·7 in the Dep. column; the nearest are 90·6 and 34·8, which give the Course 21° (N. 21° E. in this example) and Dist. 97 miles.

280. *By Computation.* (1.) For the Course. From the log. of the Dep. (adding 10 to its index if necessary) subtract the log. of the D. Lat.; the remainder is the log. tan of the Course.

(2.) For the Dist. Find the Course; then to the log. sec. of the Course add the log. of the D. Lat.; the sum is the log. of the Dist.

Ex. Dep. 34·7	log. 1·5403		Course 20° 52′	log sec. 0·0295
D. Lat. 91	log. 1·9590		D. Lat. 91	log. 1·9590
Course 20° 52′	log tan. 9·5813		Dist. 97·4	log. 1·9885
(This is the Canon (4.) No. 272.)			(This is the Canon (5.) No. 272.)	

281. *By Construction.* Draw the meridian C N. Take C B, the D. Lat. 91, and through B draw B A perpendicular to C N, and equal to 34·7; join C A; then B C A, the Course, measures 21° (No. 106, 2), and C A, the Dist. measures 98.



This example will suffice for all varieties of the case.

Case IV. Given the distance run and the difference of latitude, to find the course and departure.

Ex. A ship sails 101 miles between south and east, and makes 52 miles D. Lat.: find the Course and Dep.

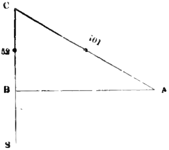
282. *By Inspection.* In Table 1, 101 in the Dist. column, and 52 in the D. Lat. column, occur over Course 59° (S. 59° E. in this example), and against the Dep. 86·6.

283. *By Computation.* (1.) For the Course. From the log. of the Dist. subtract the log. of the D. Lat.; the remainder is the log. sec. of the Course.

(2.) For the Dep. Find the Course; then to the log. sine of the Course add the log. of the Dist.; the sum is the log of the Dep.

Ex. **Dist. 101**	log. 2·0043	Course 59° 1′	log. sin. 9·9331
D. Lat. 52	log. 1·7160	Dist. 101	log. 2·0043
COURSE 59° 1	log. sec. 0·2883	DEP. 86·6	log. 1·9374
(This is the Canon (6.) No. 272.)		(This is the Canon (1.) No. 272.)	

284. *By Construction.* Draw the meridian C S. Take C B, the D. Lat. 52, and through B draw B A perpendicular to C S. From C as centre, with the Dist. 101 as radius, describe an arc cutting B A in A; then the Course, S C A, measures 59°, and B A, the Dep., measures 86·6.



This one example of construction will be sufficient.

Examples for Exercise.

Ex. 1. A ship sails from Flamborough Head, in 54° 7′ N., E. by N. ½ N. 264 miles: required her Lat. in, and Dep.
Ans. D. LAT. 76·6 N., LAT. IN, 55° 24′ N.; DEP. 252·6.

Ex. 2. A ship from Lat. 49° 57′ N. sails S.W. by W. 244 miles: required her Lat. in, and Dep.
Ans. LAT. IN 47° 41′ N.; DEP. 202·9.

Ex. 3. A ship sails S E by E. from Lat. 1° 45′ N., until she arrives in Lat. 0° 31′ S.: required her Dist. and Dep.
Ans DIST. 244·8; DEP. 203·5.

Ex. 4 A ship from St. Helena in Lat 15° 55′ S. sails N.W. ½ W. till she is in Lat. 13° 1′ S.: find the distance she has run, and the Dep.
Ans. DIST. 274·3; DEP. 212.

Ex. 5. A ship makes 135 miles northing, and 87·7 miles of Dep. westing: required her Course and Dist. made good.
Ans COURSE N. 33° W.; DIST. 161 miles

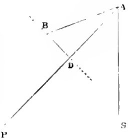
Ex. 6. A ship sails 210 miles between N. and E., and makes 160'·9 D. Lat: find the Course and Dep. Ans. COURSE N. 40° E.; DEP. 135 miles.

Ex. 7. A ship sails 244 miles between S. and W., and makes 136' D. Lat.: find the Course and Dep. Ans. COURSE S. 56° 8' W.; DEP. 202·6.

1. *Resolution of one Course upon another.*

285. It is sometimes required to resolve the distance run upon a given course into the distance upon a proposed course.

Ex. A ship is making good S. 70° W. 5¼ miles an hour: at what rate is she nearing a port bearing S.W.?



Draw the meridian, A S, of the ship at A. Lay off the bearing of the port, S W., and the Course S. 70° W., and take A B to represent the rate per hour (or for a smaller interval), as 5¼ knots. B then is the place of the ship at the end of this interval.

The distance, A P of the port, being very great, as compared with A B, a circle B D, described from P as a centre, is nearly a right line, and perp. to A P, and cuts off A D, the dist. by which the ship has neared P in an hour. Now A D is the D. Lat. to the Dist. A B, and the angle B A D as Course. B A D equal to 70° − 45°, or 25°, and Dist. 5¼, give A D equal to 5 knots, the rate required, and A D is A B resolved in the direction AP.

When the number of degrees between the given and proposed courses exceeds 90, the ship is increasing her distance from the port instead of closing it.

It is proper to observe, that the change in the distance of the port, made by the ship when not steering directly for it, is true only for its present bearing, and therefore holds only for a short time.

2. *Traverse Sailing.*

286. This is a variety of plane sailing in which the ship makes two or more courses in succession.

The process of reducing several courses, with the distances run on each, to the single course and distance which the ship would have made good if she had sailed at once from the place she first left, to the place at which she last arrived, is called *working a traverse.*

287. To work a Traverse. (1.) Draw six vertical lines. Head the space to the left Courses, the first column Distances, the next two columns D. Lat.; marking the first N. and the second S.; head the last two columns Dep., marking one E. and the other W. This forms a skeleton Traverse Table.

(2.) Set down the Courses, and the Distances against them, in order; look out in Table 1, the D. Lat. and Dep. to each Course and Distance. When the ship makes northing (that is, when the Course has an N. in it), set the D. Lat. in the N. column, otherwise in the S. column. When the ship makes easting (that is, when the Course has an E. in it), set the Dep. in the E. column, otherwise in the W. column.

(3.) Add the D. Lats. in each column; write the lesser of the two sums under the greater, and take their difference. Do the same with the Departures.

(4.) These differences are the D. Lat. and Dep. made good on the whole, and each takes the name of the column it stands in.

The course and distance are then found by No. 279.

It may be advisable for a beginner, before he proceeds to take out the quantities from the Traverse Table, to write a *dash* in all places *not* to be occupied by a D. Lat. or a Dep., in order to avoid writing a quantity in the wrong column. The first example only is thus marked, because such helps are useless to an expert computer.

Ex. A ship sails S.W. by S. 24 miles; N.N.W. 57 miles; S.E by E. ½ E. 84 miles; and South 35 miles: find the Course and Distance made good.

Courses	Dist	D. Lat.		Dep.	
		N.	S.	E.	W.
S.W. by S.	24	—	20·0	—	13·3
N.N.W.	57	52·7	—	—	21·8
S.E. by E. ½ E.	84	—	39·6	74·1	—
South.	35	—	35·0	—	—
		52·7	94·6	74·1	35·1
			52·7	35·1	
			41·9	39·0	

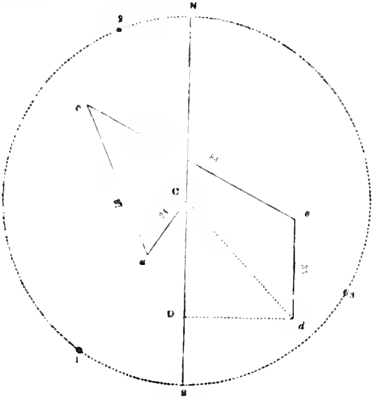
The D. Lat. 41·9 and Dep. 39·0, are found at 43° against the Dist. 57. Hence, since the ship has by the Traverse Table made southing and easting upon the whole, the Course is S. 43° E., and Dist. 57 miles.

By Computation. Each portion of the process having already been separately considered in plane sailing, nothing remains to be added here.

288. *By Construction.* With the chord of 60 describe a circle, draw the meridian N S, and mark the centre C. By means of the scale of chords lay off S 1, equal to 3 points, or S.W. by S., for the first course. Lay off N 2, equal to 2 points, or N.N.W., for the second course. Lay off S 3, equal to 5½ points, or S.E. by E. ½ E., for the third course. The fourth course, or south, is already laid off, being on the meridian.

Now lay the edge of the ruler on C and on the point 1, and lay off by the compasses, or a scale of equal parts, the first distance, C *a*, 24. Place the edge of the ruler on *a*, laying it parallel to the line joining C and the point 2, and lay off the second distance, *a b*, 57. Place the ruler on the point *b*, laying it parallel to the line joining C and the point 3, and lay off the third distance, *b c*, 84. Lay the ruler on *c*, parallel to the meridian, and lay off *c d*, the fourth distance, 35. The point *d* is therefore the place at which the ship has arrived. Join C *d*, then S C *d* is the course, 43°, and C *d* the distance, 57. Also, drawing D *d* perpendicular to C S, gives

DC the D. Lat., and D*d* the Dep. which will be found to measure 41·9 and 39·0.



The circle is here drawn outside the traverses altogether, without regard to the dimensions of the scale of chords, merely to shew the process more clearly.

This example, after the practice which the learner will have already had in drawing the figures in the preceding articles, will be sufficient for any case that may occur.

Ex. 2. A ship sails N.N.E. 11 miles; N.E. ¾ E. 39 miles; E. ½ N. 14 miles; West, 19 miles; N N.W. 4 miles: required the Course and Distance made good.

Courses	Dist.	N.	S.	E.	W.
N.N.E.	11	10·2		4·2	
N E. ¾ E.	39	23·2		31·3	
E. ½ N.	14	1·4		13·9	
West.	19				19
N. N.W.	4	3·7			1·5
		38·5	0	49·4	20·5
				20·5	
				28·9	

The D. Lat. 38·5 in the N. col., and Dep. 28·9 in the E. col give Course N. 37° E., Dist. 48 miles.

289. The D. Lat. made good on the whole, as thus found, being applied to the Lat. left, gives the Lat. in. Thus, suppose in the above example the ship left Lat. 38° 40′ S.; then 38′·5 northing places her in Lat. 38° 1′·5 S.*

Examples for Exercise.

Ex. 1. A ship from Cape St. Vincent, in lat. 37° 3′ N., sailed E.S.E. 45 miles, S.W. by W. 43 miles, S.E. by S. 64 miles, and N.N.E. 22 miles: find the Course and Distance made good, and also her Latitude in.

Ans. COURSE S. 34° E.; DIST. 89 miles; LAT. IN 35° 49′ N.

Ex. 2. A ship from Cape Amber (N.E. extremity of Madagascar), in lat. 11° 57′ S., sailed as follows: — S.S.E. ½ E. 33 miles, S.W. by W. 40 miles, S.E. by S. 44 miles; N. 36 miles, S.W. by S. 44 miles, S.E. by E. 40 miles, S.S.W. ½ W. 33 miles: required the Course and Distance made good, and also what Latitude she is in.

Ans. COURSE due South; DIST. 140 miles; the LAT. IN is 14° 17′ S.

Ex. 3. Yesterday, at noon, we were in lat. 28° 34′ N., and since then we have sailed N.E. ¾ E. 62 miles, N. by E. 16 miles, E. ¼ N. 40 miles, N.E. ¾ E. 29 miles, N. by W. 30 miles, and N. ¾ W. 14 miles: what Course and Distance have we made good, and what is our present Lat.?

Ans. COURSE N. 43° E. or N.E. ¼ N.; DIST. 158 miles; LAT. IN 30° 29′ N.

Ex. 4. Yesterday, at noon, we were in lat. 44° 10′ N., and since then we sailed the following courses (all true): S. 69° W. 4 miles, S. 58° E. 15 miles, S. 66° E. 8 miles, S. 66° W. 12 miles, S. 1° E. 6 miles, S. 55° W. 2 miles, N. 21° E. 2 miles, S. 55° W. 28 miles, S. 32° E. 14 miles, S. 55° W. 4 miles: find what Course and Distance the ship has made good, and what is her present Lat.

Ans. COURSE S. 15° W.; DIST. 55·0 miles; LAT. IN 43° 17′ N.

3. *Current Sailing.*

290. A current is named after the point *towards* which it runs or *sets*: thus, a current setting towards S.E. is called a south-east current. The mode adopted in speaking of the wind, which is named according to the point *from* which it blows, is thus reversed in speaking of a current.†

The term *set*, which is used to describe the direction of the current, is employed in the same way as in taking a bearing (No. 201); but it is necessary for the complete description of the current to state also its *drift*, that is, the distance through which the ship is carried or driven by its action.‡

291. When the rate of a current per hour is known, the drift for any number of hours is found by multiplying the rate by the number of hours.

In like manner, when the drift in a number of hours has been

* The beginner will proceed now to parallel sailing, because, though current sailing is strictly a branch of plane sailing, yet some of the examples, for the convenience of arrangement, involve the consideration of longitude.

† It is easy to conceive that people would name a wind according to the quarter it blows from, as bringing heat or cold, rain, &c., and a current according to the quarter to which it carries them.

‡ These terms have not in general been employed with sufficient precision. The term "drift" has been defined as the distance run per hour, or rate of the current. But as a second term for rate is superfluous, and as it is convenient to have a term expressive of the distance through which the ship has been carried by the current in any interval of time, we have used the word drift in the latter sense only. Thus the terms *set* and *drift* are used in speaking of the current as *course* and *distance* are in speaking of the ship.

ascertained, the rate is found by dividing the number of miles of the drift by the number of hours.

Ex. 1. A current runs 2·2 knots: required its drift in 13 hours.

Ans. 2·2 × 13 = 28·6 miles, the DRIFT.

Ex. 2. A ship is found to have drifted by the current 42 miles in 21 hours: required its rate.

Ans. $\frac{42}{21}$ = 2 miles per hour, the RATE.

292. Since the current sets the ship in a certain direction and at a certain rate, while the ship herself is going through the water in another direction and at another rate, the course of a ship affected by a current becomes in general a case of traverse sailing, in which there are two courses and distances.

Thus current sailing is analogous to traverse sailing, the two courses, instead of following in succession, being here considered as taking place at the same time.

The subjects for consideration in this section are, finding the place of a ship affected by a current; determining the course under a particular condition; and, lastly, finding the motion of the current itself.

Case I. Given the course steered, and dist. run by the log, with the set and rate of the current, to find the course and distance made good.

Ex. A ship runs N.E. by N. 18 miles in three hours, in a current setting W. by S. two miles an hour: required the Course and Dist. made good.

N.E. by N. 18 m. gives	D. Lat. 15·0 N.		Dep. 10·0 E.
W. by S. 6 m.	D. Lat. 1·2 S.		Dep. 5·9 W
	13·8 N.		4·1 E

The COURSE is, therefore, N. by E. ½ E.; DIST. 14 miles.

The Construction of this example is the same as that of a case of traverse sailing, in which the courses and distances to be laid off are N.E. by N. 18 miles, and W. by S. 6 miles.

293. When a ship steering for a port is drifted by a current, it is evident that, unless it be exactly with her or exactly against her, it will throw her out of her intended course. Since the course to be shaped in any case depends on the rate of sailing of the ship, and as this cannot be foreseen for any future hour, the course must, when it is proposed to take into consideration the effect of the current, be determined by the present rate of sailing, and independently of the distance of the port.

Case II. Given the bearing of the port, and the set and rate of the current: it is required to shape the course so as to keep the port on the same bearing.

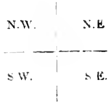
294. *By Inspection.* When the bearing of the port and the set of the current are in *adjacent* quarters of the compass, take their *sum*; when in the *same* or *opposite* quarters, take the *difference*.

With this sum (or its supplement to 16 points, or 180°, if it exceeds 90°), or difference, as a course, and the rate of the current as a distance, find the Dep.

With this Dep. as Dep. and the rate of the ship as Dist. find the Course.

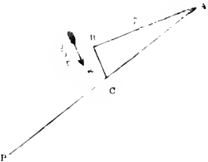
This course being applied to the bearing of the port on the *opposite* side to that towards which the current is drifting the ship, gives the course to be steered.

Ex. 1. The port bears S. 52° W., the current sets S.S.E. two miles an hour; the present rate of sailing 7 knots: shape the course so as to keep the port on the same bearing.



By Inspection. S. 52° W. and S.S.E. are in *adjacent* quarters; the *sum*, therefore, of 52° and 22°½ is 74°½. This course, with the dist 2, gives dep. 1·9. The dist 7 and dep. 1·9 give the course 16°. This 16° applied to the *right* (because, in facing towards S. 52° W. S.S.E. lies to the *left*), gives the COURSE 52° + 16°, or S. 68° W.

295. *By Construction.* Take a point B, any where, and from it lay off the set and rate of the current, as B C, S.S.E. two miles; through C draw a line A P, S. 52° W., for the direction of the port; from B lay off B A, 7, the rate of sailing, meeting P A in A; then C A B is the angle 16°, which the ship is to steer to the right of the port.



It is evident, in the present case, that while the ship is running along A B, looking to windward of the port, the current is setting her to the left towards the proposed line, A P. Attention to this point will ensure marking A on the proper side of B C; for if a line were drawn from B towards a point between C and P, to represent the ship's course, it is evident that while on it she would be looking to leeward of the port, while the current was also drifting her to leeward.

This example will serve for all cases. Thus, while the port bears as above, suppose the current sets N.N.W. 2 miles; then the point B and the line A B would lie on the S.E. side of A P instead of the N.W. side, the angle A would be 16° as before, but the distance A C made good by the ship in the direction of the port, would be different.

Ex. 2. The port bears N. 42° W., the current runs south 3 knots; rate of sailing, 5: shape the Course as required by the condition.

By Inspection. South giving no angle, the first course is 42° at once, which, with Dist. 3, gives Dep. 2. The Dist. 5 and Dep. 2 give COURSE 24°, to be applied to the *right*, because in facing towards N. 42° W., south is to the *left*.

Ex. 3. The port bears E., the current sets S W. by S. 3 knots; rate of sailing, 4.

East is 8 points, or 90°, which is one of the *opposite* quarters to S.W.; the diff. of 8 points and 3 points, or 5 points as Course, and Dist. 3, give Dep. 2·5. The Dep. 2·5, and Dist 4, give Course 39°, which, applied to the left of E., gives the COURSE to be steered N. 51° E.

Ex. 4. The port bears S. 82° E., the current sets N. 5° W. 4 knots; rate of sailing, 2.

S.E and N.W. being opposite quarters, the diff of 82° and 5°, or 77°, is the Course; which, with the Dist. 4, gives Dep. 3·9. This Dep. 3·9 being greater than the Dist. 2 (the ship's rate), which is impossible, shows that the ship cannot maintain the bearing of the port.

296. When the current sets at right angles across the line of direction of the port, the ship's velocity must evidently be equal, at least, to that of the current, that she may be able to stem it, and to preserve both the bearing and distance of the port unchanged.

Hence, if the current tend in any degree to set the ship away from her port, she will not be able to preserve the required position unless her velocity exceed that of the current.

Case III. Given the Course and Distance run by account from a well-determined place, and the true position of the ship, to find the Current.

297. *By Inspection.* Having the D. Lat. and Dep., both by account and as deduced from observation, take the difference between the two D. Lats. and the two Deps.; if the D. Lats. are of different names, take their sum, and the same of the Deps.

When the true lat. of the ship is to the north of the account, mark the diff. or sum of the D. Lats. N., otherwise S.; and when the true longitude of the ship is to the E. of the account, mark the diff or sum of the Deps. E., otherwise W. Find in the Traverse Table the course and distance corresponding to the said differences, as D. Lat. and Dep. these are the set and drift of the current.

Ex. 1. A ship in lat. 37° N., sails S. 57° E., 48 miles, by account, and is found to have made good 31′·6 D. Lat. (S.), and 44·7 Dep. (E.): find the current.

D. Lat. by account	26·1	Dep. by account	40·3
Do. true	31·6	Do. true	44·7
Diff. of D. Lats.	5·5 S.	Diff. of Deps.	4·4 E.

The D. Lat. 5·5 S., and Dep. 4·4 E., give Course S. 39° E., Dist. 7·1, the SET and DRIFT of the current in the time. Suppose the time eight hours and a half, then the RATE is 0·8 of a mile per hour.

Ex. 2. A ship from lat. 38° 20′ S., and long. 31° 15′ W., sails S. 40° E., 170 miles, by account, when she is found by observation to be in lat. 40° 54′·5 S., and long. 30° 44′·8 W.: find the current.

The lat. by account is 40° 30′ S.; the long. by account, 28° 55′ W.

Lat. left	38° 20′	Long. left	31° 15′
Lat. in	40 54·5	Long. in	30 44·8
True D. Lat.	2 34·5 = 154·5	True D. Long.	30·2

The mid. lat. 40° as Course, and Dist. 30·2, give D. Lat. 23·0. (See No. 318.)

D. Lat. by account	130·2	Dep. by account	109·3
Do. true	154·5	Do. true	23·0
Diff. of D. Lats.	24·3 S.	Diff. of Deps.	86·3 W.

The D. Lat. 24·3 S., and Dep. 86·3 W. give Course S. 74° W., Dist. 90 miles, the SET and DRIFT of the current in the given time.

Ex. 3. (By bearings and dist. of land.) A ship at sunset sets a point of land, N. 58° E., 11 miles. Next morning having, as supposed, made good S. 40° E. 14 miles, the point bears N. 70° E. 20 miles: required the current.

The Bearing at sunset, considered as a Course from the land or S. 58° W., Dist. 11, and S. 40° E. 14, give whole D. Lat. by account, between the ship and the point, 16·5 S. and Dep. 0·3 W. The Bearing and Dist. in the morning give the D. Lat. 4·8 S., and Dep. 19·4 W.

D. Lat. by account	16·5	Dep. by account	0·3
Do. true	4·8	Do. true	19·4
	11·7		19·1

The D. Lat. 11·7, and Dep. 19·1, give Course or SET 58° and Dist. or DRIFT 22; the set is evidently from the two bearings between N. and W.

The complete construction of this last case, in which longitude is involved, requires the use of Mercator's Chart. No further directions are, however, necessary than to lay off the place of the ship by D.R. and her true position; the line joining these two points shews the set of the current, and its drift.

298. The last example leads to the remark that, unless the ship's head be the same way at the taking of each bearing, as well as during the whole interval between the observations, the resulting set of the current will be mixed up with local deviation; and the current accordingly cannot be truly determined, unless the effect of local deviation be removed.

In this subdivision* rules have been laid down for working certain questions in current sailing. Other matters relative to the current, which present themselves for consideration in shaping the course, and also in determining the current itself by experiment, are treated in the division of the work entitled "Navigating the Ship."

4 *Windward Sailing.*

299. In windward sailing the vessel bound to a port has a foul wind. As she is thus compelled to make more courses than one, the case is one of Traverse Sailing; but as the course on either tack is determined by the circumstances, the inquiry is limited to the consideration of the time at which it is proper to tack.

The general principle, supposing the wind to remain unchanged, is to near the port as much as possible from instant to instant. Now the ship nears the port fastest on that tack on which she looks the best up for it; if, therefore, she looks up for the port better on her present tack than she would on the other, she should stand on; if not, she should go about. Hence it follows, that the ship should constantly keep the port in the wind's eye; but, as working up on this line would require the vessel to be continually tacking, which is practically impossible, the limits within which the rule should be followed must be determined by circumstances.

The advantage of working up nearly in the stream of the wind towards any object, whether fixed or moving, is, that the wind cannot be worse, and, therefore, every change must be for the better.†

300. The distance run, or the ground actually gone over, is the same whether the ship makes two boards or a greater number, pro-

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* As it is convenient occasionally thus to refer by name to the several parts into which, from the classification adopted, the contents of this volume are divided, it may be stated briefly that the principal portions, as the Introduction, Navigation, &c., are here termed *divisions*, which, when necessary, are divided into *chapters*. The parts of a division or of a chapter, distinguished by capital letters, are termed *sections*; the parts of a section in large italics, *subdivisions*, and the further division of these, in small italics with figures in brackets, *subsections*, the prefix *sub* being thus applied to the smallest divisions.

† The question of closing another vessel belongs to tactics, and not to our present subject, which relates solely to the place of the ship on the sea. It may not be useless, however, to notice here, that in working up to a vessel to windward, it is proper to keep as near the stream of the wind as circumstances permit; because from the time that the chase has drawn to the weather beam of the chaser, the latter, however great her superiority of sailing, ceases to near the chase. See Naut. Mag. 1838, Art. "Chasing," p. 146.

vided that no ground or time is lost in stays: the application of the above rule, therefore, depends entirely on the probability of a change of wind.

In this subdivision we consider merely the general principle of sailing with a foul wind. Other points involved in Shaping the Course, as the combination of a current with a foul wind, the selection of such a course as may, in certain cases, convert a foul wind into a fair one, the effects of local deviation which have been observed while sailing on different tacks, will be treated in the Chapter on Navigating the Ship, under the heads "Shaping the Course," "Error of the Course."

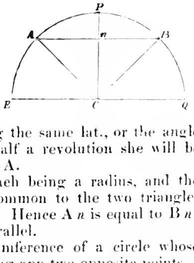
II. Parallel Sailing.

301. When two places lie on the same parallel of latitude, or due east and west of each other, the distance between them, estimated along a parallel, or E. and W. (which is all departure), is converted into difference of longitude; or, on the other hand, their difference of longitude is converted into distance,—by the rules of Parallel Sailing.

The principles of Parallel Sailing are contained in the two following propositions.

302. Prop. A parallel of latitude is a circle of which the radius is proportional to the cosine of the latitude.

Let E P Q be part of a meridian, P the pole, E Q a diameter of the equator, A a place whose latitude is the arc A E.



Take B Q equal to A E; then B is the opposite point to A on the same parallel. Join A B crossing C P in *n*.

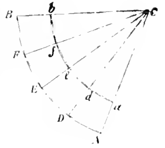
Suppose now a ship to move from A round the polar axis C P, preserving the same lat., or the angle P C A constant; then at the end of half a revolution she will be at B, and P C B will be equal to P C A.

Then C A and C B being equal, each being a radius, and the angles P C A, P C B, equal, and C *n* common to the two triangles A C *n*, B C *n*, these are equal (No. 117). Hence A *n* is equal to B *n*; and this holds for every point of the parallel.

Hence A and B are on the circumference of a circle whose centre is *n*, in the line or diameter joining any two opposite points.

Now A *n* (see fig. p. 44) is equal to the cosine of the arc A E, C E being radius; hence C E : A *n* :: rad. (= 1) : cos lat., which was to be proved.

303 Prop. The length of a circular arc is proportional to its radius. Or, the length of A B : the length of *a b* :: C A : C *a*.



C is the common centre of the arcs A B, $a\,b$. Divide the angle C into any number of equal parts, as for ex. four, by the lines C D, C E, C F; join the points A and D, &c. by the chords A D, D E, &c. Then the sides C A, C D, &c. being equal, and the angles A C D, D C E, &c. being equal, the bases A D, D E, &c. are all equal (No. 117.)

In like manner the chords $a\,d$, $d\,e$, &c. are all equal.

Now the triangles C A D, C $a\,d$, being isosceles, and having one angle A C D common, have the remaining angles equal; they are thus equiangular, and therefore similar (148 cor.), and their sides are proportional (146); hence A D : $a\,d$ :: C A : C a.

We may multiply both terms of the ratio A D : $a\,d$ by any number without altering its value (Nos. 37 and 7), whence 4 A D : 4 $a\,d$ :: C A : C a. Now 4 A D is the sum of the four equal chords A D, D E, &c., and 4 $a\,d$ is that of the chords $a\,d$, $d\,e$, &c. Hence,

The sum of the equal chords of A B : sum of the same number of equal chords of $a\,b$ :: C A : C a.

This proportion is evidently true, whatever be the number of equal parts into which the angle C is divided. It would therefore hold equally for an immensely increased number of diminished chords, as for ex. of 1′, or 1″, or a millionth of 1″, or infinitely less; it therefore holds of the arc itself, which we may conceive to be composed of an indefinitely great number of indefinitely small portions, each of which is arc or chord indifferently,* or arc A B : arc $a\,b$ :: C A : C a.

(1). If A B be the equator, and $a\,b$ a parallel, then C A : C a :: 1 : cos lat. Whence A B : $a\,b$ :: 1 : cos lat.

And since Diff. Long. is an arc of the equator, and an arc measured parallel to it in any other latitude is called Dep., we have,

D. Long. : Dep. :: 1 : cos. lat., whence Dep. = D. Long. × cos. lat. . . . (1)

Dep. : D. Long. :: 1 : sec. lat., (162 (2) (4)) D. Long. = Dep. × sec. lat. . . . . . . (2)

These are the equations for Parallel Sailing.

(2). These equations, in logarithms, become

Log Dep. = log. D. Long. + log. cos. lat. . . . . . . (1)

Log. D. Long. = log. Dep. + log. sec. lat. − 10 . . . (2)

Case I. Given the distance run on a given parallel of latitude, to find the difference of longitude.

304. *By Inspection.* (1.) Enter the Traverse Table with the latitude as a course, and look in the D. Lat. column for the given distance; the Dist. against this is the Diff. Long. required.

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* As, from the nature of the case, the sum of all the chords can never *surpass* the arc, though it may approach indefinitely near it, the arc is said to be the *limit* of the sum of the chords increased indefinitely.

Ex. A ship runs 143 miles due W. in Lat. 38° 11′: required the diff. long. she makes good.

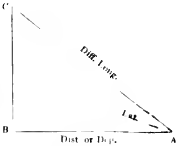
The lat. 38° as course, and 143 in the D. Lat. column, give the Dist. 181, or 3° 1′: the DIFF. LONG. required.

(2.) Or employ Table 3, as directed in the Explanation of the Tables.

305. *By Computation.* To the log. sec. of the Lat. add the log. of the Dist.; the sum (rejecting 10) is the log. of the Diff. Long.

Ex. above.	Lat.	38° 11′	log. sec. 0·1046
	Dist.	143	log 2·1553
	DIFF. LONG.	181·9	log. 2·2599

306. *By Construction.* Draw a line A B east and west, and lay off 143 on it; lay off the angle B A C equal to the Lat. or 38° in this case; draw B C perpendicular to A B, and meeting A C in C. Then A C is the Diff. Long. required.



Case II. Given the Diff. Long. of two places on the same parallel, to find their distance as measured along the parallel.

307. *By Inspection.* (1.) Enter the Traverse Table with the Lat. as course and the Diff. Long. as distance; the D. Lat. is the distance required.

Ex. The diff. long. of two places in the parallel of 53° 20′ is 12° 14′: required their distance as measured along their parallel.

The lat. 53° as Course, and Dist. 734, give in the D. Lat. column 442 nearly: the DISTANCE required.

(2). Or employ Tab. 4, as directed in the Explanation of the Tables.

308. *By Computation.* To the log. cos. of the Lat. add the log. of the Diff. Long.; the sum (rejecting 10) is the log. of the distance required.

Ex. above.	Lat. 53° 20′	log. cos. 9·7761
	D. Long. 12 14 or 734	log. 2·8657
	DIST. 438·3	log. 2·6418

309. *By Construction.* Draw a line A B (fig. No. 306) of any length; lay off at A the angle B A C equal to the latitude 53°; take A C equal to the Diff. Long. 734; from C draw C B perpendicular to A B; then A B is the Dist. required, and measures 442.

310. In parallel sailing the Distance and Departure are identical. When the course is nearly, though not exactly, on a parallel, the distance run and the departure are very nearly equal; hence it is evident that parallel sailing will apply, nearly enough for common purposes, to cases in which the course is not exactly east or west.

311. In lats. below 5°, when the distance does not exceed 300 miles, the Dep. may at once be taken as the Diff. Long., as the greatest error will scarcely exceed 1′.

1. *Middle Latitude Sailing.*

312. This is a method (founded on the principle of parallel sailing) of converting the Departure into Difference of Longitude, and the Difference of Longitude into Departure, when the ship's course lies obliquely across the meridian; that is when, besides Departure, she makes Difference of Latitude.

Suppose a ship make 100 miles departure in going, on the same course, from lat. 38° to lat. 41°; this departure, if made good altogether in lat. 38°, would give 127 Diff. Long. by No. 304; and again, if made good in lat. 41°, it would give 132·5 Diff. Long. Now, since the ship has sailed between these two parallels, and not on either of them exclusively, her real Diff. Long. must be between 127 and 132·5; and therefore we may conclude it to be not far from that which would result from a departure made good altogether in the *middle parallel;* hence the name of the sailing.

313. Middle latitude sailing has thus the same two cases as parallel sailing; and, accordingly, the rules for inspection, computation, and construction, already given, Nos. 304, &c., apply equally to this sailing, observing merely to read *middle latitude* for *latitude.*

314. When the latitudes of the two places are of the *same* name, the middle lat. is half their *sum.**

In using the Traverse Tables, it is enough to take the latitudes to the nearest degree.

Ex. 1. A ship sails from lat. 51° 33′ N. to 49° 9′ N.: find the Mid. Lat.

Lat left	52°
Lat. in	49
	101
Mid. Lat.	50

Ex. 2. A ship sails from lat. 2° N. to lat. 1° S.

The ship moving near the equator, the consideration of middle latitude is omitted, and the Dep. taken as the Diff. Long.

When the latitudes are of *contrary* names, no sensible error can arise from taking the Dep. itself, made good from day to day, as the Diff. Long. But in greater distances between places in opposite latitudes it is proper to convert the Dep. made good in N. lat. into Diff. Long. by means of the north mid. lat., that is, half the N. latitude, and that made good in S. lat. by half the S. lat.

When, on the other hand, the Diff. Long. is to be converted into Dep., this rule does not apply. It will be near enough for common purposes, when the latitudes are either very nearly equal or very unequal, to employ, as the mid. lat., half the greater latitude. In

* The rule which directs half the difference of the latitudes of two places on opposite sides of the equator to be employed as their middle latitude, is erroneous. The error will be readily perceived in considering a case. Suppose a ship sails S E. from lat. 10° N. to 10° S; it is evident that her diff. long. will be exactly the same as if, on reaching the equator, she returned to the same N. lat., steering N.E., since her course is the same, and she moves in the same lats. in both cases. Thus the mid. lat., which is the average of all the latitudes passed through, or the half sum of the first and last, and is here 5°, is independent of the distinctions of N. and S. The common rule gives 0 for the mid. lat.; whence it would follow that the diff. long. made good by a ship in ranging through all the latitudes between 10° N. and 10° S., or any other equal latitudes, however great, would be the same as if she made good her departure altogether on the equator — a conclusion manifestly erroneous.

an intermediate case we may combine the two mid. lats., giving the greater weight to that which corresponds to the greater latitude.

Ex. 1. Find the mid. lat. between 30° N. and 25° S.
The lats. being nearly equal, half of 30°, or 15°, may be taken as the MID. LAT

Ex. 2. Find the mid. lat. between 30° N. and 2° S.
Half of 30°, or 15°, may be taken as the MID. LAT.

Ex. 3. Find the mid. lat. between 30° N and 15° S.
The N. mid. lat. is 15°, the S. mid. lat. is 7° nearly; now the mid. lat. 15° corresponds to 30° of lat., and the other, or 7°, to only half as much. Instead, therefore, of dividing the sum of the two by 2, we give to the first double the weight of the other, and divide by 3; thus, 15 + 15 + 7, or 37 divided by 3, gives 12°, the MID. LAT. required, nearly.

Case I. Given the departure, to find the difference of longitude.

Ex. 1. A ship from lat. 51° 9′ N. sails S.W. by W. 216 miles: required her Lat. in and Diff. Long.

315. *By Inspection.* Find the D. Lat. and Dep., and the Lat. in. Find the Mid. Lat.; then, with the Mid. Lat. as Course, look for the Dep. in the *D. Lat. column*, the corresponding Dist. is the D. Long. required.

By Case I. of Plane Sailing, S. 5 points, Dist. 216, give D. Lat. 120 and Dep. 179·6; hence the Lat. in is 49° 9′ N.

Lat. left	51 9 N.	
	100 18	Mid. Lat. 50°

Then Course 50° and Dep. 179·6 in the D. Lat. column give Dist. 279 or 4° 39′, the DIFF. LONG. required.

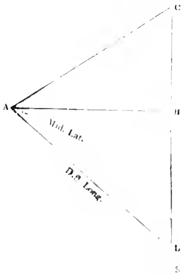
316. *By Computation.* Having found the Dep. and the Mid. Lat., add together the log. sec. of the Mid. Lat. and the log. of the Dep.; the sum (rejecting 10) is the log. of the Diff. Long.

Ex. above. Dep. 179·6 Mid. Lat. 50° 9′

Mid. Lat.	50° 9′	log. sec. 0·1933
Dep.	179 6	log. 2·2543
DIFF. LONG.	280·3 (4° 40′·3)	log. 2·4476

317. *By Construction.* (Ex. 1.) Lay off S C A the Course 5 points, and take C A the Dist. 216; draw A B perpendicular to C S. The figure is thus far complete for plane sailing, Case I.

Lay off the angle B A L equal to the Mid. Lat. 50°, and A L meeting C S is the Diff. Long. 280.



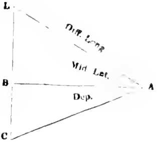
Ex. 2. A ship from Lat. 29° 40′ N. sails E.N.E. till she makes 72 miles D. lat.: required the Dist. run and Diff. Long.

By Inspection. By No. 276, Course 6 points and D Lat. 71·9 give Dep. 173·7; and 72 miles northing give lat. in 30° 52′ N.

Lat. left	29° 40′ N.
Lat. in	30 52 N.
	60 32
Mid. Lat.	30 16

Course 30° (Mid. Lat.) and Dep. 173·7 as D. Lat. give Dist. 201 or 3° 21′, the DIFF. LONG. required.

By Construction. C B A represents the fig. for plane sailing.



Lay off B A L equal to the mid. lat. 30°; and A L is the Diff. Long. and measures 201.

These two examples of construction are sufficient for the case.

Ex. 3. A ship from lat. 44° 58′ N. runs 230 miles, and makes 56 miles southing: find the Course and Diff. Long.

By Case IV. of Plane Sailing, p. 86, the Dist. 230 and D. Lat. 56 stand together over the Course 76 and against the Dep. 223·2; then 56′ southing gives Lat. in 44° 2′ N.

The Lat. left 44° and Lat. in 45° give the Mid. Lat. 44 ½ or 44°.

Course 44° (Mid. Lat.) and Dep. 22·3 in D. Lat. column give Dist. 31: hence the DIFF. LONG. is 310, or 5° 10′.

Case II. Given the latitudes and longitudes of two places, to find the departure, and thence the course and distance between them.

Ex. Find the Course and Dist. between C. Sierra Leone, in lat. 8° 30′ N., long. 13° 8′ W., and C. St. Roque, lat. 5° 28′ S., long. 35° 17′ W.

318. *By Inspection.* Find the Mid. Lat. and the Diff. Long. of the places; open the Traverse Table at the Mid. Lat. as a course, look for the Diff. Long. in the Dist. column, and take out the D. Lat.: this is the Dep. required.

The Dep. and given Diff. Lat. between the places give the Course and Dist. by Case III. Plane Sailing, p. 109.

C. Sierra Leone, lat.	8° 30′ N.	Long.	13° 18′ W.
C. St. Roque	5 28 S.		35 17 W.
D. Lat.	13 58	Diff. Long.	21 59
Or	838 miles	Or	1319 miles.

The Mid. Lat. of 8° 30′ is 4° 15′, that of 5° 28′ is 2° 44′, or 4° and 3° nearly. As 4° corresponds to the greater lat., we may adopt it as the Mid. Lat. (Assigning the relative weights with some further precision gives 3° 40′ as the Mid. Lat.)

Course 4° (Mid. Lat.) and Dist. 132 give 131·7 in the D. Lat. col.; this as Dep., and D. Lat. 83·8, give COURSE 57°½, DIST. 1570 miles.

319. *By Computation.* Find the Diff. Long. and the Mid. Lat., to the log. cos. of the Mid. Lat. add the log. of the Diff. Long.: the sum is the log. of the Dep.

Ex. above. D Lat. 838, D. Long. 1319, Mid. Lat. 3° 40′.

Mid. Lat.	3° 40′	log. cos.	9·9991
Diff. Long.	1319	log.	3·1202
DEP.	1316	log.	3·1193

The Dep. being now found and the D. Lat. given, the Course and Dist. may be found. (No. 279.)

Construction. Construct the triangle for turning the Diff. Long. into Dep., as in No. 306 (reading Mid. Lat. for Lat.). Then having the D. Lat. and Dep. the process is completed by drawing the figure as for Case III. of Plane Sailing, p. 109.

320. When the Mid. Lat. is below 5°, and Dist. under 300 miles, see No. 311.

Examples for Exercise.

Ex. 1. If a ship from Tynemouth Castle, in Lat. 55° 1′ N. and Long. 1° 25′ W., sails S.E. by S. 296 miles: what is her present latitude and longitude?

Ans. Lat. in 50° 55′ N.; Diff. Long. 273m.; Long in, 3° 8′ E.

Ex. 2. A ship from Cape Clear, in Lat. 51° 26′ N. and Long. 9° 29′ W., sails S.W. 263 miles: required her Lat. and Long.

Ans. Lat 48° 20′; Diff. Long. 288·7, whence the Long. in is 14° 18′ W.

Ex. 3. Find the Course and Distance between Tynemouth and the Naze of Norway.

Ans. Course N. 57° 42′ E.; Distance, 331·3 miles

Ex. 4. Required the Course and Distance from a place A, in Lat. 51° 25′ N. and Long 9° 29′ W., to a place B, in Lat. 36° 57′ N. and Long 25° 6′ W.

Ans. Course S. 37° 45′ W.; Distance, 1098 miles.

Ex. 5. Required the Course and Distance from a place A, in Lat. 56° 12′ N. and Long. 2° 36′ W. to a place B, in Lat. 57° 58′ N. and Long. 7° 3′ E.

Ans. Course N. 71° 23′ E.; Distance, 332 miles.

Ex. 6. Required the Course and Distance from A to B; Lat. of A 53° 18′ N.; Long. of A 0° 55′ E.; Lat. of B, 57° 58′ N.; Long. B 7° 3′ E.

Ans. Course N. 36° 34′ E.; Distance, 349 miles.

2. *Mercator's Sailing.*

321. This sailing is employed for exactly the same purposes as middle latitude sailing; but it is a perfect method, which the other is not.

The calculations are performed by the help of a table of Meridional Parts, Table 6.

322. To find the *Meridional Difference of Latitude.* When the latitudes are of the *same* name, take the *difference* of the meridional parts for the two latitudes; when of *contrary* names, take the *sum.*

Case I. Given the course between two places, and their latitudes, to find their difference of longitude.

Ex. 1. (Lats. *same* name.) A ship from lat. 51° 9′ N. sails S.W. by W. 216 miles: required the Lat. in and Diff. Long.

323. *By Inspection.* Having found the Lat. in, take out the meridional parts (Table 6) for it, and for the Lat. left; find the Meridional Diff. Lat. (No. 322).

With the Course, and Mer. D. Lat. in the D. Lat. column, find the Dep.; this is the Diff. Long.

By Case I. No. 273, the Course 5 points and Dist. 216 give D. Lat. 120 and Dep. 179·6; thus D. Lat subtracted from 51 9′ gives Lat. in, 49° 9′ N.

Lat. in	49° 9′ N.	Mer. parts	3396
Lat. left	51 9	——	3583
		Mer. D Lat.	187

The Course 5 points and D. Lat. 187 give Dep. 280, or 4° 40′ the Diff. Long.

324. *By Computation.* Find the Lat. in, and the Mer. D. Lat. To the log. tan. of the Course add the log. of the Mer. D. Lat.; the sum (rejecting 10) is the log. of the D. Long.

Ex. above. Lats. 49° 9′ and 51 9′, Course 5 points.

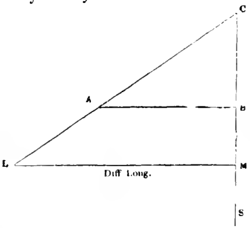
5 points		log tan.	10·1751
Mer. D. Lat.	187	log.	2·2718
Diff. Long.	279·8, or 4° 39′·8	log.	2·4469

(This is the canon (3) No 272. It will be sufficiently understood by observing that, in the fig. below, C M is the Mer. D. Lat., and M L the Diff. Long., and C M : M L :: rad. : tan. M C L the course.

This example is sufficient for any variety of the Case I.

325. *By Construction.* Lay off the course M C A, S 5 points W.; take C A 216 the Dist.; draw A B perp. to C S: the fig. C A B is, thus far, the case for plane sailing.

Now lay off C M the Mer. D. Lat. 187, and draw M L parallel to A B meeting C A produced: M L is the Diff. Long. and measures 280.



This example of construction is sufficient for Case I.

Ex 2. A ship from lat. 29° 40′ N. sails E.N.E. till she makes 72 miles D. Lat.: find her Diff. Long.

By Inspection. Course 6 points and D. Lat. 72 give Dist. 188 miles: the Lat. in is 30° 52′.

Lat. left	29° 40′	Mer. parts	1865
Lat. in	30 52	—	1949
		Mer. D. Lat.	84

Course 6 points and D. Lat. 84, give Dep. 203, or 3° 23′, the Diff. Long.

Case II. Given the latitudes and longitudes of two places to find the course and distance between them.

Ex. Find the Course and Distance between Ushant, in lat. 48° 28′ N. long. 5° 3′ W, and St. Michael's, lat. 37° 44′ N. long. 25° 40′ W.

326. *By Inspection.* Take out the mer. parts for the two lats.: find the Mer. D. Lat. and the Diff. Long.

Enter the Traverse Table with the Mer. D. Lat. as D. Lat. and the D. Long. as Dep.: this gives the Course.

Then with this Course and the *true* D. Lat. find the Dist., which is the distance required.

Ushant, lat.	48° 28′ N.	Mer. parts	3334	Long.	5° 3′ W.
St. Mich.	37 44		2448		25 40 W.
	10 44	Mer. D. Lat.	886		20 37
True D. Lat.	644			Diff. Long.	1237

Then 88·6 as D. Lat. and Dep. 123·7 give Course 54°; and D. Lat. 644 gives 1095 miles, the Dist. required.

327. *By Computation* (1.) For the Course. Find the Mer. Diff. Lat. and the Diff. Long. From the log. of the Diff. Long. (adding 10 to the index if necessary) subtract the log. of the Mer. D. Lat.: the remainder is the log. tan. of the Course.

(2.) For the Distance. Find the course; then to its log. sec. add the log. of the true D. Lat.: the sum is the log. of the Distance.

Ex. above. M. D. Lat. 886; D. Long. 1237; true D. Lat 644.

Diff. Long.	1237	log.	3·0924	Course	54° 24′	log. sec.	0·2350
Mer. D. Dat.	886	log.	2·9474	Tr. D. Lat.	644	log.	2·8089
Course	54° 24′	tan.	0·1450	Dist.	1106	log	3·0439

328. *By Construction.* Draw the meridian C S* through one of the places, say Ushant, and on it lay off the Mer. D. Lat., 886 from C to M. Draw M L perpendicular to C S and equal to the Diff Long. 1237; join C L, and S C L is the Course.

Lay off C B the true D. Lat. on C S, draw B A parallel to L M and C A is the Dist. 1106.

329. When the lat. is below 5° and the dist. less than 300 m., see No. 332.

Examples for Exercise.

Ex. 1. A ship, in Lat. 36° 40′ S. and Long. 16° 20′ E., sails W. N.W. until she arrives in Lat. 33° 10′ S.: find the Diff. of Long. and also the Long. come to.

Ans. Diff. Long. 620·4W.; whence the Long. come to is 6° 0′ E.

Ex. 2. A ship from Lat. 42° 25′ N. and Long. 15° 6′ W. sails N.E. by E. for several days, and then finds by observation she is in Lat. 46° 40′ N.: find what Diff. of Long she has made; also find her Long. in.

Ans. Diff. Long. 536; whence her Long. in is 6° 10′ W.

Ex. 3. A ship, in Lat. 42° 30′ N. and Long. 58° 51′ W., sails S.E. by S. 300 miles: find the Diff. Long., and also the Long. in.

Ans. Diff. Long. 219 miles; Long. in 55° 12′ W

Ex. 4. Find the Course and Distance between Tynemouth and the Naze of Norway.

Ans. Course N. 57° 40′ E.; Distance, 331·4 miles.

Ex. 5. Required the Course and Distance between Tynemouth and Helgoland.

Ans. Course S. 81° 8′ E.; Distance, 324 miles.

Ex. 6. Required the Course and Distance from Diego Ramirez, in Lat. 56° 29′ S., Long. 68° 43′ W., and C. Lopatka, in Lat. 51° 2′ N., Long. 156° 46′ E.

Ans. Course N. 46° 21′ E.; Distance, 9346 miles

3. *Selection of Mid. Lat. or Mercator's Sailing.*

[I.] *Finding the Diff. Long.*

330. The difference of longitude found by Mid. Lat. is true at the equator, and very nearly true for short distances in all latitudes especially when the course is nearly E. or W. In high latitudes, when the distance is great and the course oblique, the error becomes considerable; but the result may be made as accurate as we please by subdividing the distance run into small portions, and finding the Diff. Long. for each portion separately.

331. The Diff. Long. deduced by Mid. Lat. sailing is too small: an estimate of the error for places on the same side of the equator may be formed by the help of a few cases. Suppose the course 4 points or 45°, and the D. Lat. 10° or 600 miles; then if this D. Lat. is made good in any latitude below 30° the error of the D. Long. will not exceed 2′; if made good between the parallels of 40° and 50° the error will be about 3′; and between 60° and 70°, about 19′, or ⅓ of a degree. For smaller distances the errors will be much

* The figure in the preceding page will, after the various examples given, serve sufficiently well to illustrate generally the construction of this case. The learner will merely observe, that if the other place was to the *northward* of Ushant, the Mer. Diff. Lat. C M would be laid off to the *northward* of C. In like manner, if the other place was to the *eastward* of Ushant, the D. Long. M L would be laid off to the *eastward*, or to the right of the meridian.

less, and for greater distances much greater, as they vary in much more rapid proportion than the distances.*

332. It is proper to remark that when the Course is large, that is, near seven or eight points, the D. Long. should be found by middle latitude in preference to Mercator's Sailing; because, although the latter is mathematically correct in principle, yet a small error in the Course may, when the Course is large, produce a considerable error in the Difference of Longitude.

The reason of this is easily shewn. In mid. lat. sailing we convert the *departure* into D. Long. The process increases the Dep. in a proportion which is less than 2 to 1 in all latitudes below 60°, and exceeds 3 to 1 in latitudes beyond 70°. The error of the Dep., increased in the same proportion, becomes thus the error of the D. Long. Now when the course is nearly E. or W. the Dep. is nearly the same as the distance, and an error of some degrees in the course does not affect the Dep. sensibly; hence in this case the error of the D. Long. depends on that of the Dist. alone.

But in Mercator's Sailing, on the other hand, we convert the *Mer. Diff. Lat.* into D. Long., and the process, when the Course is large, converts a given Mer. Diff. Lat. into a D. Long. much greater than itself; and thus increases the error of the Mer. Diff. Lat. in the same proportion. Thus, for example, at the course 80° the D. Long. exceeds the Mer. Diff. Lat. in the proportion of 6 to 1; at the course 85° this proportion is 11 to 1. Now when the course is large a slight change in it sensibly affects the D. Lat., and also the Mer. Diff. Lat., which is deduced directly from it.

In high latitudes the Mer. parts vary rapidly, and the error of the D. Long. is aggravated accordingly; hence the precept more especially demands attention in high latitudes.

[2.] *Finding the Course or Bearing.*

333. The bearing of the port is truly deduced in low latitudes and at short distances by the method of Mid. Lats.; but the result cannot be rendered accurate in high latitudes by subdividing the distance, which is unknown, into small portions: such cases are truly solved by Mercator's sailing.

When the bearing is large, or near 90°, the method of Mid. Lats. should be preferred to Mercator.

334. The course or bearing computed by mid. lat. sailing is too great. The error, however, in ordinary cases, will be much less than that to which the ship's course itself is liable.

335. The Course as reduced by Traverse sailing, from several courses, does not afford accurately whether by Mercator's or Middle Latitude Sailing, the Diff. Long. made good by the ship, because the

* The proper mid. lat. to employ should be somewhat greater than the mean of the lats. A Table has been given, by Workman ("Navigation Improved," London, 1805), shewing the correction to be added to the mean of the latitudes, in order to obtain true results. But for common purposes the usual method, of which the recommendation in practice is its great convenience, would seem to be near enough, and when more precision is required the complete solution by Mercator's Sailing is effected with very little more labour. (See No. 334.)

Diff. Long. made good on any Course depends entirely upon the latitude in which the ship actually moves.

Ex 1. A ship sails from Lat. 70° N.; 1st, N.E. 400 miles to Lat. 74° 43′, then S.E. 400 miles, when she returns to the parallel of 70°, having made Dep. 556 miles, and D. Long. 31° 18′.

Ex. 2. She sails 556 miles on the parallel of 70°, making D. Long. 27° 34′.

Ex. 3. Starting from 70°, as above, she sails S.E. 400 miles to Lat. 65° 17′, then N.E. 400 miles to 70°, having made 556 miles of Dep. and D. Long. 24° 54′.

The 1st and 3d case, reducing the two courses to one by the Traverse Table, give the same Course and Dist. made good as in Case 2, viz. East 556 miles, or Dep. 556 m., and D. Long. 27° 34′, which is erroneous. In Case 1, this Dep. is made good in the average lat. of 72°½; in Case 2, in 70°; and in Case 3, in 68°.

It may appear perplexing to the student that the ship should return to the *same parallel*, after having made a *given Dep.*, and yet that her long., that is, her position in the parallel, should be different in different cases; but he must bear in mind that the Dep. has not been made good *on the parallel*, except in Case 2. If he lays off a case of the kind on the globe, he will perceive clearly the nature of the question.

To obtain accurately the Diff. Long. each course should therefore be separately considered. But, in general, except in very high lats., the distances are not large enough to introduce much error on this account.

III. Great Circle Sailing.

336. When the ship sails on a rhumb line (No. 198), her track cuts all the meridians as she passes them in succession, at the same angle; and thus, while steering a course, her head is kept on the *same point of the compass* until she reaches her intended port. This condition, namely, keeping the course constant, is the most convenient in practice, and, besides, produces in all the calculations in which the place of the ship is concerned the utmost simplicity of which they are capable. But the track on the rhumb line is not the *shortest distance* measured directly over the surface of the sphere from one place to another, or the distance "as the crow flies," except when the course is due north or south, or east or west on the equator. The shortest distance between two points on the surface of a sphere is the portion or arc which they include of the circle passing through both the points and the centre of the sphere. Such a circle is called a *great circle*,* as distinguished from other circles whose centres do

* The great circle passing through two places may be found on a globe by stretching a thread evenly between them; or, by turning the globe about till the two places fall on the upper edge of the wooden rim, or horizon of the globe, which thus marks the circle. The distance between the points may be measured at once by laying the thread along the equator of the globe. The courses are found by measuring the angles between the thread and the meridians; the most convenient instrument for which is the horn semicircle, or protractor, as it is also called (No 108). In order to compare the great circle with the rhumb line the latter must be projected on the globe.

not coincide with the centre of the sphere; as, for instance, the parallels of latitude, of which the centres are in the axis between the centre and the pole, and which are called *small* circles. Hence sailing on a circle of the former kind is called Great Circle Sailing.* On this course, and on this course alone, the ship steers for her port as if it were in sight.

The three arcs joining two points on the surface of a sphere with each other, and with a third point, and having for their common centre the centre of the sphere, constitute a Spherical Triangle. In the problem under consideration the two places are the two points, and the third point is the pole, and the triangle is formed by the distance between the places and their colatitudes. Some of the rules in this section may be employed accordingly in other problems of spherical trigonometry.

337. Great Circle Sailing is adapted principally to the second only of the two cases, No. 270, or Shaping the Course; because the ship, even when moving on a great circle, must necessarily be kept on the same course (that is, on a rhumb line) for a short distance at a time, and her place may then be deduced by the rules already given in the preceding section with incomparably greater convenience than it could by any rule in which the distance made good was rigorously considered as described on a circle. Although this sailing is thus restricted to one case, we shall, for the sake of clearness, divide the problem of finding the course by *Inspection* into two cases, namely, Case I. in which the places are on the *same* side of the equator, and Case II. in which they are on *opposite* sides.

Case I. *By Inspection.* (The places on the *same* side of the equator.)

(1.) For the Dist. With the two lats. enter the Spherical Traverse Table (Table 5), and take out M and N.

With the complement of the Diff. Long. as a Course and Dist. 100 (Table 2), find the Dep., and write it under N.

When the Diff. Long. is *less* than 90°, *add* this Dep. to N.; when the Diff. Long. is *greater* than 90°, take the *diff.* of the Dep and N.

With this sum (or diff.) as D Lat. and M as Dist. find the arc in Table 2: this is the Distance required in degrees of 60 miles each.

(2.) For the Course. Having found the Distance. With the lat *in*, and the compl. of the Dist. in degrees, find M. and N (Table 5.)

With the lat. *to* as Course and M as Dist. (Table 2), find the Dep., and write it under N. When the Diff. Long. is *less* than 90°, take the *diff.* between this Dep. and N. When the Diff. Long. exceeds 90°, take the *sum* of the Dep. and N.

With this diff. (or sum) as D. Lat. and Dist. 100 (Table 2), find the Course.

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* Parallel sailing, for a like reason, is sailing on a *small* circle.

The Course is to be reckoned according to the following rule:

Dist. *less* than 90° (or 5400 miles).		Dist. *greater* than 90° (or 5400 miles).
Dep. *less* than N.	Dep. *greater* than N.	
Course to be reckoned	Course to be reckoned	Course to be reckoned
in N. lat. from S. in S. lat. from N.	in N. lat. from N. in S. lat. from S.	in N. lat. from N. in S. lat. from S.

Ex. 1. Find the Distance between St. Helena, in lat. 15° 55′ S., long. 5° 44′ W., and Cape Horn, in lat. 55° 59′ S. and long. 67° 16′ W., and the Course from each place to the other.

The D. Long. between 5° 44′ W. and 67° 16′ W. is 61° 32′; compl. 28°.

For the Distance.

16° and 56° (the lats.) give	M 186·0	N 42·5
28° (co-diff. long.) and Dist. 100 give		Dep. 46·9
(D. Long. less than 90°.)		*Sum* 89·4

The Dist. 186·0 and D. Lat. 89·4 give 61° nearly, or Dist. 3660 miles. The complement of 61° is 29°.

For the Course from St. Helena.

16° (Lat. *in*) and co-Dist. 29°	M 118·9	N 15·9
56 (Lat. *to*) and Dist. 118·9		Dep. 98·6
(D. Long. *less* than 90°.)		*Diff.* 82·7

Dist. 100 and D. Lat. 82·7 give 34°, which is S. 34° W., the Course required, because the Dist. is *less* than 90°, the Dep. *greater* than N, and the Lat. is south.

For the Course from C. Horn.

56° (Lat. *in*) and co-Dist. 29°	M 204·5	N 82·2
16 (Lat. *to*) and Dist. 204·5		Dep. 56·3
		Diff. 25·9

Dist. 100 and D. Lat. 25·9 give 75°, which is N. 75° E., the Course required, because the Dist. is *less* than 90°, the Dep. *less* than N, and the Lat. is south.

By Mercator's Sailing the Course is 50° from either place to the other, and the Distance 3740 miles.

Ex. 2. Find the Distance between Madeira, in lat. 32° 38′ N., long. 16° 55′ W., and Bermuda, in lat. 32° 20′ N., long. 64° 51′ W., and the Course from Madeira.

The D. Long. is 47° 56′; the compl. 42°.

For the Distance.

32° and 33°	M 140·6	N 40·6
42 (co-D. Long.) and 100		Dep. 66·9
		Sum 107·5

Dist. 141 and D. Lat. 107·5 give 40°, or 2400 miles, the Dist. required.

For the Course.

33° (Mad.) and co-Dist. 50°	M 185·5	N 77·4
32° (Berm.) and 185·5		Dep. 98·3
		Diff. 20·9

Dist. 100 and D. Lat. 20·9 give 78°, which is N. 78° W., the Course required, because the Dist. is *less* than 90, the Dep. *greater* than N, and the Lat. north.

Ex. 3. Find the Distance between a point in long. 180° on the equator, and another in lat. 40° N., long. 140° W., and the Courses between these points.

For the Distance. Lats 0° and 40° give M 130·5 and N 0. Then 50° (the co-D. Long.) and Dist. 100 give Dep. 76·6; the sum of N and this is 76·6, and Dist. 130·5 with D. Lat. 76·6 gives 54°, or Dist. 3240 miles.

For the Course from Lat. 0°. 0° and the co-Dist. 36° give M 123·6, N 0; 40° and 124 give Dep. 79·7; Dist. 100 and D. Lat. 79·7 give 37°, which is N. 37° E., the Course required.

For the Course from Lat. 40°. 40° and 36° give M 161·4, N 61·0; 0 and Dist. 161 give Dep. 0; Dist. 100 and D. Lat. 61·0 give 52°, which is S. 52° W., the Course required as the Dep. 0 is less than N.

338. Case II. *By Inspection.* (The places on *opposite sides* of the equator.)

(1.) For the Distance. With the two lats. take out M and N. (Table 5.)

With the complement of the D. Long. as Course (Table 2), and Dist. 100, find the Dep.

When the D. Long. is *less* than 90°, take the *difference* between this Dep. and N; when the D. Long. is *greater* than 90°, take the *sum*.

With this diff. or sum as D. Lat. and M as Dist. find the Course or arc in Table 2.

When the D. Long. is *less* than 90°. If the Dep. is *greater* than N, this arc is the Dist. required; if the Dep. is *less* than N, take the supplement.

When the D. Long. is *greater* than 90°, take the supplement of the arc.

(2.) For the Course. Having found the Distance, with the Lat. *in* and the complement of the Dist. to 90°, find M and N.

With the Lat. *to* as course and M as Dist. (Table 2), find the Dep.

When the D. Long. is *less* than 90°, take the *sum* of this Dep. and N; when the D. Long. is *greater* than 90°, take the *difference*.

With this sum or diff. as D. Lat. and Dist. 100 (Table 2), find the Course, which is to be reckoned as follows:—

Dist. *less* than 90° (or 5400 miles.)	Dist. *greater* than 90° (or 5400 miles)	
	Dep. *less* than N.	Dep. *greater* than N.
Course to be reckoned	Course to be reckoned	Course to be reckoned
in N. lat. from S. in S. lat. from N.	in N. lat. from N. in S. lat. from S.	in N. lat. from S. in S. lat. from N.

Ex 1. Find the Distance between C. Palmas, in lat. 4° 22′ N. long. 7° 44′ W., and C. Frio, in lat. 23° 0′ S. long. 41° 57′ W., and the Course from each place to the other.

The D. Long. is 34° 13′; the complement is 65°.

For the Distance.

4° and 23° (lats.) give M 108·9 N 3·0
56° (co-Diff. Long.) and 100 Dep. 82·9
(D. Long *less* than 90°.) *Diff.* 79·9

Dist. 109 and D. Lat. 79·9 give 43°, or Dist. 2580 miles; the compl. is 47°.

For the Course from C. Palmas.

4° (C. Pal.) and 47° M 147·0, N 7·5
23° (C. Frio) and 147 Dep. 57·4
(D. Long. *less* than 90°.) *Sum* 64·9

Dist. 100 and D. Lat. 64·9 give 49°, which is S. 49° W., the Course required, because the Dist. is *less* than 90° and the Lat. is north.

For the Course from C. Frio.

23° (C. Frio) and 47° M 159·3, N 45·5
4½ (C. Pal.) and 159 Dep. 12·5
Sum 58·0

Dist. 100 and D. Lat. 58·0 give 55°, which is N. 55° E., the Course required, because the Lat. is south.

Ex 2. Find the Courses and Distance between Diego Ramirez, in lat. 56° 29′ S. long 68 43′ W. and C. Lopatka, in lat 51° 2 N. long. 156° 46′ E. The D. Long is 134° 31′, the co-D. Long 45°.

For the Distance. 51° and 56½ give M 288·0, N 186·6. Then 44½° and Dist. 100 give Dep. 70·1; the *sum* of N. and Dep., or 256·7 as D. Lat., and Dist. 288, give 27, or Dist 153°, or 9180 miles: the co-dist. is 63°.

For the Course from Diego Ramirez. 56½° and 63° give M 399·1, N 296·6; 51° and 399 give Dep. 310·0; the *diff.* 13·4 and Dist. 100 give 82°: Course, N. 82° W.

For the Course from C. Lopatka. 51 and 63° give M 350·0, N 242·4; 56½° and 350 give Dep. 291·8; the *diff.* 49·4 and Dist. 100 give 60°: Course, S. 60° E.

339. To find the Courses and the Distance between the places *by Computation*. Find the co-latitudes of the places. If the places are on different sides of the equator, add 90° to the latitude of one of them for its co-latitude. Find the D. Long., and take half of it.

(1.) For the Courses. Take half the sum of the colats. and half their diff. Add together the log. cot. of half the D. Long., the log. sec. of the half sum, and the log. cos. of the half difference: the sum (rejecting tens) is the log. tang. of half the sum of the two courses.

When the half sum of the colats. exceeds 90°, take the supplement of the resulting arc for the half sum required.

To the same log. cot. add the log. cosec. of half the sum of the colats., and the log. sine of half their diff.; the sum (rejecting tens) is the log. tan. of half the difference of the two courses.

The *sum* of the half sum and half diff. of the two courses is the course from the place in the *smaller* of the two co-latitudes to the other; the *difference* of the said half sum and half diff. is the other course.

The course is to be reckoned from the N. point in north latitude, and from the S. point in south latitude.

Ex. 1. Find the Courses on the great circle, between St Helena, in lat. 15° 55′ S., long. 5° 44′ W., and C. Horn, in lat. 55° 59′ S., long. 67° 16′ W.

The D. Long. is 61° 32′; half D. 30° 46′.

Colat.	34°	1′	(C. Horn)	30° 46′	cot. 0·2252		0·2252		
Colat.	74	5	(St. Helena)						
Sum	108	6	half sum	54 3	sec 0·2313		cosec. 0·0918		cos. 9·7687
Diff.	40	4	half diff.	20 2	cos. 9·9729		sin. 9·5347		sin. 9·7089
				69° 35′	tan. 0·4294	35° 24′	tan. 9·8517	69° 35′	sec. 10·4574
				35 24				30 34	cos. 9·9350
			Course, S	104 59	E. from C. Horn, or N. 75° 1′ E.			2	
			Course, S.	34 11	W. from St. Helena.			61 8	= 3668 m.*

Ex. 2. Find the Courses on the great circle between Diego Ramirez, in lat. 56° 29′ S., long 68° 43′ W., and C. Lopatka, in lat. 51° 2′ N., long. 156° 46′ E.

The D. Long. is 134° 31′; the co-lats. 33° 31′ and 141° 2′. The half sum of the required courses is 79° 8′, and the half diff. 18° 42′. The sum of these is the Course from colat. 33° 31′, or Diego Ramirez, S. 97° 50′ W., or N. 82° 10′ W.; the diff. is the Course from C. Lopatka, or S. 60° 20′ E.

(2.) For the Distance. By above method,* or take the supplement of the Diff. Long. to 12^h or 180°. Add together the two co-lats.

Add together the log. sine square of the said supplement, and the log. sines of the co-latitudes: the sum (rejecting tens) is the log. sine square of an auxiliary arc x †

Write x under the sum of the colats., and take the sum and difference, and the half sum and half difference.

Add together the log. sines of the last two terms: the sum (rejecting tens) is the log. sine square of the Distance required.

† Log sine square is identical with the log. haversine of Inman's tables.

Ex. Find the Distance between St. Helena, in lat. 15° 55′ S., long. 5° 44′ W., and C. Horn, in lat. 55° 59′ S. and long. 67° 16′ W.

Diff. Long.	61° 32′		
Suppl.	118 28	log. sin. sq.	9·868247
Colat.	34 1	log. sin.	9·747749
Colat.	74 5	log. sin.	9·983022
Sum	108 6		
Arc x	78 8	log. sin. sq.	9·599018
Sum	186 14		
Diff.	29 58		
½ Sum	93 7	log. sin.	9·999357
½ Diff.	14 59	log. sin.	9·412524
Dist. 61° 4′, or 3664 miles.		log sin. sq.	9·411881

The Distance by Mercator's Sailing (No. 327) is 3736 miles, or 72 more.

340. The course on the rhumb line,* from one of two places to the other, is exactly the opposite of the course to that place from the other; while, on the great circle, as appears from the preceding examples, these courses are very different. The ship, while on the rhumb line, is always changing the direction of her head with respect to her port, for which she never steers exactly until it is in sight, because this track cuts all the meridians at the same angle. and the meridians themselves are not parallel to each other; but on a great circle she steers directly for her port, while, as the angle made by her track with the meridians is perpetually varying, the direction of her head appears by the compass to be continually changing. This track, accordingly, is the only one on which the ship nears her port by the whole amount of distance which she makes good from instant to instant.

Great circle sailing includes the case of sailing on a meridian or due N. and S., and on the equator, because the meridians and equator are great circles.

341. While sailing at the same rate on the same rhumb, the ship always changes her latitude by the same quantity; but while sailing at the same rate on the great circle she may change her latitude, not only by unequal quantities, but in opposite directions. For example, suppose the polar seas navigable, then the shortest way for the ship to go from a point in the arctic circle (or any other parallel of north latitude) to another point 180° of longitude from it, and in the same latitude, would be to cross the pole; in which case she would first steer north and then south, whereas on the rhumb line she would constantly steer east or west.

342. The track on the great circle and that on the rhumb line differ most widely from each other in high latitudes, and between places on nearly the same parallels. On the other hand, when the places are on opposite sides of the equator, the great circle and rhumb line intersect each other, and the difference between them is not so conspicuous. In low latitudes, and in all latitudes when the course is nearly on a meridian, the two curves nearly coincide.

343. If the arc of the great circle passing through the two places (not being both on the same meridian or on the equator) be pro-

* Also called the loxodromic curve.

duced beyond them, and carried round the globe, it will pass through two points diametrically opposite in latitude and longitude, which we have called *vertexes*, each of them being the highest point in latitude N. and S., passed through by the circle. The vertex is 90° from the point where the great circle between the places (or produced beyond them) cuts the equator.

When the course shaped on the great circle from each place is less than 90° (reckoning both courses from the nearest pole), the vertex falls between the places. At this point the ship, neither increasing nor diminishing her latitude for a time, steers E. or W. But when the course from one of the places exceeds 90°, the vertex of the circle falls outside the arc joining them.

344. To find the Latitude and Longitude of the Vertex.

(1.) For the Latitude. To the log. cos. of the lat. of one of the places add the log. sine of the course, on the great circle, from this place to the other: the sum is the log. cos. of the lat. required.

(2.) For the Longitude. Add together the log. cosec. of the latitude already employed, and the log. cot. of the course already employed: the sum is the log. tan. of the D. Long. between the vertex and the place worked from.

Ex. 1. Find the vertex of the great circle passing through Rio de Janeiro, in lat. 22° 55′ S. long. 43° 9′ W., and the Cape of Good Hope, in lat. 34° 22′ S. long. 18° 30′ E.

The Course from Rio is S. 63° 12′ E., that from the Cape S. 84° 54′ W.; each of these courses, reckoned from S., being less than 90°, the vertex falls between the places

Latitude.			Longitude.			
Rio, lat.	22° 55′	cos.* 9·9643		22° 55	cosec.	0·4096
Course	63 12	sin. 9·9506		63 12	cot.	9·7034
LAT.	34° 42′	cos. 9·9149	D. Long.	52° 23′	tan.	0·1130
			Rio	43 9 W.		
			LONG.	9 14 E.		

Ex. 2. Find the vertex on the great circle passing through St. Helena and C. Horn.

By Ex. No. 339, the Course from St. Helena is S. 34° 12′ W., that from C. Horn is S. 104° 58′ E.; since one of these courses exceeds 90°, the vertex falls without.

Ans. Lat. 57° 17′ S.; Long. 85° 10′ W.

345. When the ship sails on a great circle between two places on the same side of the equator, she is always in a *higher latitude* than if she had sailed on the rhumb line; hence, since both tracks coincide at their extremities, there must be a point in the great circle at which its distance from the rhumb line, measured on a meridian, is greater than anywhere else; this point we shall call the point of *Maximum Separation in Latitude*.

When the ship crosses the equator, there are two such points, the one being to the northward of the rhumb line in north latitude, and the other to the southward of the rhumb line in south latitude.

346. The track of the great circle between any two points

* As none but the logarithmic sines, cosines, &c. are employed in this work, except in No. 251, we shall henceforth, for brevity, dispense with the abbreviation *log* in the examples

may be conveniently shewn, by determining the latitude of its point of intersection with each of a certain number of intervening meridians, the degree of exactness being increased according to the number of meridians taken.

To find the latitude of the point where the great circle passing through two places intersects any given meridian,

Find the position of the vertex (No. 344).

To the log. tan. of the lat. of the vertex add the log. cos. of the difference of long. between it and the given meridian, and the sum is the log. tan. of the required latitude.

Ex. Find the latitude of the point where the great circle passing through St. Helena and Cape Horn intersects the meridian of 30° W.

Vertex (Ex. 2 344) lat. 57° 17′ S., long. 85° 10′ W.

Latitude	57	17′	tan.	0·1922
Diff. Longitude	55	10	cos.	9·7568
Required Latitude	41	39	tan.	9·9490

The log. tan. of the lat. of the vertex being constant, the lats. of the points of intersection of the great circle with any desired number of meridians may thus be rapidly computed.

347. To facilitate the practice of Great Circle Sailing, Mr. J. T. Towson in 1847 devised a method by which, using a diagram and a table, the successive courses on the great circle can be found without the labour of calculation.*

The manner of projecting the track, and of measuring the distance on Mercator's chart, are described in Chap. V. Other matters demanding consideration when it is proposed to make a voyage on a great circle, are treated in the division of the work appropriated to Navigating the Ship.†

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* Towson's Tables for facilitating Great Circle Sailing. Sold by J. D. Potter, 145 Minories, London, E.

† The Azimuth and Star-azimuth Tables of Burdwood and Davis also facilitate Great Circle Sailing. The lat. in being taken as the Lat., the lat. of the port bound to as the Dec., and the diff. long. as the Hour-angle, gives the Azimuth, which will be the True Course. From these the Great Circle Course may be projected on the Chart. *See* Burdwood and Davis' Azimuth Tables, published by Potter, 145 Minories.

Ex., a ship bound from Cape King, entrance of Yedo Bay, to San Francisco. Cape King, lat. 34° 54′ N., long 139° 53′ E. San Francisco, lat 37° 48′ N., long. 122° 29′ W. Diff. long. 97° 38′, or $6^h\ 30^m\ 32^s$.

Lat. in.	Lat. bound to.	Diff. long. as Hour-angle.	Azimuth or True Course.	Cutting Mer. of
35°	38°	$6^h\ 30^m$	N. 54° E.	150° E in lat 41°
41	38	5 50	N. 61 E.	160 E. „ 45
45	38	5 10	N. 68 E.	170 E. „ 48
48	38	4 30	N 75 E.	180 „ 49
49	38	3 50	N. 83 E.	170 W. „ 50
50	38	3 10	N. 91 E.	160 W. „ 50
50	38	2 30	N. 100 E.	150 W. „ 49
49	38	1 50	N. 109 E.	140 W. „ 47
47	38	1 10	N. 119 E.	130 W. „ 43
43	38	... ...	N. 131 E.	San Francisco.

CHAPTER IV.

Taking Departures.

I. By a Single Bearing and Distance. II. Determination of Distance. III. Methods by the Chart.

348. Determining the place of the ship with reference to a point of land, or other position of known latitude and longitude, is called *Taking a Departure.*

The position of the ship with respect to a point of land or other fixed and conspicuous object is defined by the *direction* in which she lies, and her *distance* from it.

The *direction* or bearing of the ship from the land, being the opposite of the bearing of the land from the ship, is furnished at once by the compass, or it may be found by observation of an *Astronomical Bearing;* but the *distance* from the point, when it cannot be estimated or guessed with sufficient precision, must be deduced by means of some further observation, taken at the same time as the bearing, or after an interval.

When a former position of the ship herself is adopted as a point of departure, the direction (or course) and the distance are deduced from the reckoning.

I. By a Single Bearing and Distance.

349. The object being set by the compass, its distance is estimated by the eye.

This, which is the common method of taking departures, is near enough when the distance is small; but the error or uncertainty in the estimation of the distance, which, perhaps, may be stated generally at one-fifth of the whole, becomes considerable when the distance is great. Distances thus estimated are generally overrated.

II. Determination of Distance.

1. *By two Bearings of the same Object.*

350. When the ship's path lies across the line of direction of the object, the distance can be obtained by two bearings and the distance run by the ship in the interval of time between them

Take the bearing of the object, and note the number of points contained between it and the ship's head. After the bearing has altered not less than two or three points, note the number of points in the same angle again.

NOTE. The course and distance between the positions must be those actually *made good*.

(1.) To find the distance when the *last* bearing was taken.

Enter Table 7 with the first number of points at the top and the second number of points at the side; take out the number corresponding, and multiply it by the number of miles made good by the ship: the result is the dist. in miles at the time the *last* bearing was taken.*

Ex. The Eddystone bore N.W. by W.; after running W. by S. 8 miles, it bore N.N.E.: required its Dist. at this last bearing.

The number of points between N.W. by W. and W. by S. is 4; that between N.N.E. and W. by S. is 11; under 4 at the top and against 11 at the side stands 0·72, which multiplied by 8 (miles), gives 5·8 miles, the DIST. required.

The student can easily supply a figure.

(2.) To find the distance when the *first* bearing was taken.

Enter the Table with the supplement (or difference from 16 points) of the second number of points at the top, and the supplement of the first number of points at the side; take out the multiplier, and proceed as above directed.

Ex. Find the Distance of the Eddystone at the time the first bearing (or N.W. by W. above) was taken.

The second number of points is 11, the supplement of which is 5; the first number is 4 points, the supplement of which is 12; then 5 at the top and 12 at the side give the number 0·85, which multiplied by 8 gives 6·8 miles, the DIST. required.

When the number of points between the object and the ship's head at either observation is 8, that is, when the bearing is at right angles to the course, the distance may be found by the Traverse Table, by entering the table with the number of points at the other observation as a course, and the distance run as D. Lat.; the corresponding Dep. is the distance of the object when observed at 90° from the course.

351. If the time be noted when an object is 4 points on the bow, and again when it is right abeam, the distance run in the interval on the same course is evidently equal to the distance off the object when abeam. This case is called the *Four-point bearing*. It is, however, only a case of the general problem. If a ship having a point of land or other object at any angle on the bow, proceeds steering the same course till a position is reached where the angle on the bow is doubled, the distance from the object at the last position is equal to the distance between the two positions. The case is most favourable when from the positions chosen the object is 30° before and 30° abaft the beam; the triangle is then equilateral.

* This Table was constructed at the suggestion of Sir F. Beaufort, and first appeared in the *Nautical Magazine*, vol. i. p. 208

The error of the required distance produced by an error in the dist. run, is a matter of simple proportion. For example, if the dist. run be $\frac{1}{10}$ of itself in error, the distance required will also be $\frac{1}{10}$ of itself in error. Hence the dist. run should not be much less than the distance required.

2. *By Sound.*

352. An excellent mode of determining the distance is obtained by noting the number of seconds elapsed between seeing the flash of a gun and hearing the report. Sound travels, in a calm, about 1130 feet in one second at a temperature of 66° Fahr.; hence it is easy to deduce the following approximate rule.

Divide the seconds elapsed by 5, and subtract from the quotient $\frac{1}{12}$ of itself; the result is the Dist. in miles very nearly.

Ex. The mean of the intervals given by 4 guns fired from C. Shilling was 14·1 required the Dist. of the ship.

	5) 14·1
	2·8
1-twelfth of 2·8	·2
Dist.	2·6

This method is capable of much precision when the gun and the ear are at the same temperature and at the same height.* A moderate breeze in the direction of the sound causes a variation of about 20 feet a second in the velocity; a strong breeze more.

3. *By the Altitude of High Land.*

[1.] *When the Object is seen on the Sea-Horizon.*

353. The distance of the visible horizon from the spectator is equal to the true depression or dip of the eye in Table 8, increased by about $\frac{1}{12}$ of itself.† Thus, if the eye be twenty feet above the sea, the horizon is distant five miles and about half a mile more.

When, therefore, the sea-horizon is seen beyond the object, the distance of the latter is less than the depression.

354. When the summit, or any other point of known height of an object situated beyond the sea-horizon is seen *on this line*, its distance is at once known; for since the eye, the horizon, and the object are in the same straight line, the same horizon corresponds to both the height of the eye and that of the object; the distance, therefore, between these two points is, by No. 205, the sum of the depressions corresponding to the two heights.

Ex. From the mast-head, 87 feet above the sea, the Lizard Light, the height of which is 223 feet above low-water mark, is seen on the horizon: required its distance.

The dip (Table 8) to 87 feet is 10′, that to 223 is 16′; the sum 26 increased by $\frac{1}{12}$ of 26, or 2′, is 28 miles the Dist. required.

* The uncertainty to which this method is liable (though not worth notice in navigation) may, when precision is required, be removed, in the ordinary state of the atmosphere, by firing a gun at each extremity of the line, and taking the mean of the observed intervals.

† In this and the following rules $\frac{1}{12}$ is used instead of $\frac{1}{11}$ (see No. 207), because 12 is an easier divisor than 11. The difference is not worth notice.

This method will often be useful, but from the great uncertainty of terrestrial refraction it is impossible to assign with precision the degree of dependance.

[2.] *When the Object is seen above the Sea-Horizon.*

355. Case I. When the height of the summit, or other point of high land, is known, its distance is found by means of the altitude observed above the sea-horizon with a quadrant or sextant.*

356. *The Observation.* Observe the altitude of the summit, and estimate its distance in miles.

When the altitude exceeds 3° see No. 359.

357. *The Computation.* Alt. under 3°. (1.) Correct the alt. for index error (No. 496), and subtract from it $\frac{1}{12}$ of the estimated distance; the remainder is the true alt.

When the height of the eye exceeds 30 feet, add $\frac{1}{12}$ of the corresponding Depression; the sum is the true altitude.

(2.) From the true alt. subtract the true Depression to the height of the eye, Table 8: note the remainder.

To the square of the Depression corresponding to the height of the summit add the square of the remainder (which is found at once in the column headed "Square," against the remainder as a Depression). Look for the sum in the column headed "Square," and take out the Depression corresponding; from this take the remainder: the result is the distance of the summit in miles.†

Ex. 1. The alt. of a hill 2000 feet high is observed 56′; corr. for index error, −3′; the height of the eye, 20 feet; estimated Dist. 8 leagues, or 24 miles: required its Distance.

Deducting $\frac{1}{12}$ of 24, or 2′, and 3′ error, leaves true alt. 51′.

True alt.	51′	Square of Depr. to 2000 ft.	2304
True Depr. to 20 ft.	− 5	Ditto of Rem. 46′	+ 2116
Rem.	46	Depr. 67′ Square	4420
		Rem.	− 46
		Dist. required	21′ or miles.

Ex. 2. April 19th, 1829, Mr. Fisher observed from the poop of H.M.S. Spartiate, 74, the alt. of Mount Etna, 1° 26′ 30″; index corr. + 1′ 30″; height of eye, 30 feet; estimated dist. 20 leagues: required its Distance. Height of Etna, 10900 feet.

	1° 26′	Square of Depr. to 10900 ft.	12321
$\frac{1}{12}$ of 60′, −5′ } Ind. cor. +2 }	− 3	Ditto of Rem. 77′	+ 5929
Alt.	1 23	Depr. 135′ Square	18250
True Dep. to 30 ft.	− 6	Rem.	− 77
Rem.	1 17 or 77′	Dist. required	58′ or miles.

The distance by the chart was 57 miles.

358. When the distance is too great for estimation, and the altitude low, the computation must be repeated.

Ex. Captain Beechey observed from H.M.S. Sulphur, the Peak of Teneriffe clearly defined against the setting sun; mean of 3 alts. on the arc, 19′ 32″; off the arc, 19′ 50″; the

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* In this instance, reference is necessarily made to the use of instruments which belong principally to Nautical Astronomy, and are, therefore, described in that subject, Chap. II.

† When the height of the eye exceeds 30 feet, subtract from the sum of the two squares (above) the square of the corresponding Depression. From the nature of the observation, it is enough to work to minutes only.

mean, 19 41; height of the eye, 18 feet; height of the Peak, 12172 feet: required its Distance.

Alt.	20′	Square of Depr. to 12200 ft.			13689
Depr.	− 4	Ditto of Rem. 16′			+ 256
Rem.	16	Depr.	118′	Square	13945
			− 16		
		DIST. required	102′ or miles.		

Using this now as an *estimated* distance, and repeating the work, gives 109 miles. It was found next day by the chronometers to have been 115 miles.

359. When the altitude is great, or above 3°, the following rule for the computation is preferable to No. 357 :—

(1.) Correct the altitude for index error, subtract from it $\frac{1}{12}$ of the estimated distance in miles, subtract further the true Depr. of the eye (Table 8), and note the remainder.

When the height of the eye exceeds 30 feet, increase the remainder by $\frac{1}{12}$ of the depression.

(2.) Add the log. cos. of this remainder to the log. cos. of the Depr. corresponding to the height of the mountain; the sum (rejecting 10) is the log. cos. of an arc. From this arc take the said remainder, this leaves the Dist. of the summit in miles.

Ex. Mr. Fisher observed the altitude of Mount Etna, 5° 15′; height of the eye, 30 feet; estimated distance, 8 leagues, or 24 miles: required its Distance.

Alt.	5° 15′	Etna, ht. 10900 ft. Dep.	1° 51′	cos. 9·999774
$\frac{1}{12}$ of 24	− 2 }	...... Remainder	5 8	cos. 9·998255
Depr.	− 5 }		5° 27′	cos. 9·998029
		Remainder	5 8	
		DIST.	19 miles.	

360. *Degree of Dependance.* To judge of this, repeat the computation, using a new altitude, varied from the former by a number of minutes equal to the extent of the probable uncertainty.

For example. Suppose in Ex. 1, No. 357, the altitude doubtful, or in error, 5′; repeating the work, with the altitude 46′, gives the distance 23 miles, instead of 21: hence we infer that, supposing 5′ to be in this case the utmost probable uncertainty in the altitude, the distance may be depended upon to 2 miles.

The greater the altitude the more accurate is the result.

361. Case II. When the height of the land is not known, the distance may be found while standing directly towards it, or from it, by means of two altitudes, and the distance run in the interval between them.

If the course is not more than two points out of the direction of the object, the distance run may be reduced to the change of distance of the object by means of the Traverse Table.

362. *The Observation.* Observe the altitude. After a considerable change in the altitude, observe a second altitude at the same height of the eye. Note the rate of sailing. Estimate the distance at each observation.

363. *The Computation.* Find the true altitudes, No. 357. (1.) Find from the rate of sailing the dist. run, and reduce it when necessary to the change of distance made good in the direction of the object, thus,—enter Table 1 with the difference between the ship's

course and the bearing of the object as a Course, and the Dist. run as Dist.; the corresponding D. Lat. is the change of distance required.

To the lesser altitude add half the change of distance, and subtract the Depr. corresponding to the height of the eye; call this the first remainder. From the greater altitude subtract the lesser altitude, and the change of distance; call this remainder the second remainder.

Multiply the first remainder by the change of distance, and divide the product by the second remainder; the quotient is the distance in miles when the *greater* altitude was taken.

Ex. 1. Observed altitude of Mount Etna, 1° 28′; estimated distance, 20 leagues. When 38 miles nearer, observed the altitude 5° 15′; height of the eye, 30 feet: required the Distance.

1° 28′, deducting $\frac{1}{12}$ of 60 miles or 5′, is 1° 23′; 5° 15′, deducting $\frac{1}{12}$ of 22 miles or 2′, is 5° 13′.

Lesser Alt.	1° 23′	Greater Alt.	5° 13′	then $\frac{96 \times 38}{192} = 19$ miles,
½ Dist. run	+ 19	Lesser do. 1° 23′ }		the Dist. required.
Depr.	− 6	Dist. + 38 }	−2 1	
1st rem.	1 36	2d rem.	3 12	
or	96	or	192	

Ex. 2. Observed the altitude of Dunnose 41′, estimated distance 4 leagues or 12 miles After running 7½ miles directly from it observed the alt. 20′. Height of the eye, 10 feet.

The 1st alt. reduced is 18′; the 2d, 40′. The 1st rem. is 18·7; the 2d, 14·5: the Dist. required 9·7 miles.

364. *Degree of Dependance.* This may be estimated by repeating the work with a new lesser alt., and also with a new change of distance, differing from those used before by 1′, and comparing these two results with the first. If they do not differ much, the case is evidently but little affected by small errors; if, on the contrary, they differ more than 1′, it is shewn that errors of observation are increased in the result.

Thus an error of 1′ in the lesser alt. produces in Ex. 1, above, only 0·3 of a mile error in the distance required, while in Ex. 2, the latter error is 1·2.

Again, an error of 1 mile in the change of distance produces in Ex. 1 only 0·7 of a mile in the result, while in Ex. 2, it produces 2·4 miles.

In ordinary cases an error of 1′ or 2′ is more likely to occur in an alt. than an error of 1 or 2 miles in the change of distance; and as precision is of less consequence in the greater than in the lesser alt. the value of the result will depend principally on the lesser altitude.

The less the 1st rem. is with respect to the 2d, the less is the effect produced by the above errors on the result.

Thus, in Ex. 1, the 1st rem. is to the 2d, or 96 is to 192, as 1 to 2 nearly, and the case is good. In Ex. 2, on the contrary, the 1st rem. 18·7, is greater than the 2d, 14·5, and the result could not be depended upon within 2 or 3 miles.

365. Since these rules suppose the object to be referred to the sea-horizon, they apply to all cases in which the observer, though near the land, can descend so near the surface of the water as to obtain a perfect sea-horizon.

On the other hand, when the land is very distant, or the altitude very small, the methods in this section must not be too confidently depended upon, especially in a calm, or when, from heat, vapour, or other cause, there is anything unusual in the appearance of the horizon.

Useful tables of *Vertical Danger Angles* of heights from 50 to 18,000 feet, to distances off; from one cable to 110 miles, have been calculated by Lieut. S. T. S. Lecky, R.N.R. Published by George Philip & Son, London and Liverpool, 5th Edition, 1890.

III. Methods by the Chart.

1. *Cross Bearings.*

366. The *true* bearings of two points of land being obtained, draw lines through them on the chart in the directions of the bearings; these lines cross in the place of the ship.

Or a *true* bearing of one of the points of land may be obtained, and an angle measured by the sextant (Nos. 485–504) between it and a second point, when the second point cannot be conveniently seen from the compass.

367. When the difference of bearings is near 90°, this is the most complete of all methods; but if the difference is small, as for example, less than 10° or 20°, or near 180°, the ship's position will be uncertain, because a small error in the bearing will then cause a great error in the distance.

2. *By Two Angles between Three Objects.*

368. When the ship's place is required to considerable accuracy, as, for example, in recovering a lost anchor, verifying the soundings on the chart, or other purposes, it should be determined by means of two angles observed between three objects on shore.

(1.) A convenient method of laying down on the chart the angles observed, is to draw with a pencil on tracing or transparent paper, or on paper oiled for the purpose, lines containing the observed angles; then, laying this paper on the chart, and moving it about until the lines drawn pass over the respective objects. The angular point where they meet will shew the true place of the observer.

The horn protractor (No. 108) may sometimes be conveniently employed, as lines may be drawn on it with a pencil.*

369. *By Construction.* The observer is always on a circle passing through his own place and any two objects (No. 103); also the angle

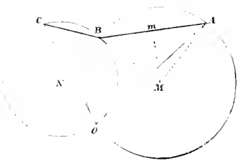
* The Station-pointer, an instrument used in this case to fix a ship's position, consists of three flat rulers, two movable from a common centre right and left of the third, which is fixed. The angular distance at which the movable rulers are required to be placed on either side of the fixed ruler being measured by an attached circular arc.

subtended by the two objects is the same at all points of the circumference on one side of the objects (No. 140). Hence, by observing this angle and laying it off, he can draw the circle on which he is, but cannot determine his position upon it. If now he adds a third object, he can draw a second circle passing through this and either of the other two, and his place is the intersection of the two circles.

Ex. 1. Let A B C be three objects on the chart; the angle between A and B, formed at O, the observer, is 46°; that between B and C is 30°.

Join A B, B C; lay off the angles B A M, A B M, each equal to the complement of 46°, or 44°; then the intersection of the lines A M, B M, is the centre of the circle A B O.

In like manner lay off B C N, C B N, each equal to the complement of 30°, or 60°; then N is the centre of the circle C B O, and O is the place of the observer.

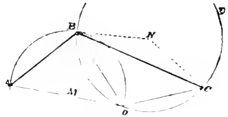


The drawing of the figure is materially simplified, in practice, by the bearing of the middle object, as this shews where the lines must fall.

Ex. 2. The angle between two objects A, B, is 47°, that between B and C is 107°.

Lay off A B M, B A M, each equal to 43°; M is the centre of A B O.

Lay off C B N, B C N, each equal to the complement of 107°, or 17°, then N is the centre of C B O.



370. *Demonstration.* Having laid off two equal angles A B M B A M, and described a circle from M the point of intersection of A M, B M, bisect A B (fig. Ex. 1) in *m*, and join *m* N; also take a point O any where in the circumference, and join O A, O B.

Then M *m* is perp. to A B (No. 144), and also bisects the angle A M B (cor.) or A M *m* is half A M B. Also A O B at the circumference is half A M B at the centre (No. 139); hence, A O B and *m* M A are equal, and *m* A M the complement of A M *m* is also the complement of A O B. A circle therefore has been described which has the given angle at the circumference.

The same proof applies when the angle at O exceeds 90°. Thus, in fig. Ex. 2, B O C, 107°, is measured by half the arc B D C (supposing the circle completed, and B D, D C, joined), which is therefore 214°. Hence the *arc* B O C is 360° − 214°, or 146°, and the angle B D C measured by half this, is 73°; B N C is 2 × 73°, or 146°, and N B C (or N C B its equal), which is the complement of half B N C, is 90° − 73°, or 17°, which is the complement of 107°.

371. It is evident that the place of O is most distinctly marked when the circles cross each other at a considerable angle; and, on the other hand, that the result is unsatisfactory when the two circles nearly coincide, or when their centres are near together. These conditions govern the choice of objects.

372. In thus fixing the ship by two angles observed between

three well-known objects on shore, the centre object should always be the nearest; for if the ship should happen to be on the circumference of the circle passing through the three selected points, her position cannot be obtained by the means of two angles only. A *true* bearing of one of the objects is therefore desirable.

It will readily be seen that in war time, when the compass may be knocked away, or rifle-fire may make it undesirable to expose the person more than necessary, a sextant offers great advantages, as angles can be obtained from any position whence the objects are visible. It is this contingency that makes it especially desirable that sailors should become expert in the method of fixing a ship's position with the sextant.

3. *By the Soundings.*

373. When the depth of water is not great, and also varies sensibly with the distance from the point of land set, this distance may be found from the chart by means of the soundings.

4. *By a Bearing, and the Lat. or Long. of the Ship.*

374. When the lat. of the ship is known, the true bearing of a well-fixed point, less than 4 points from the meridian, or not much more, affords a very accurate departure. In like manner, when the long. of the ship is known, the bearing of a given point more than 4 points from the meridian, or not much less, affords the departure.

In certain cases the bearing (alone) of a point of land may be determined from the long. by chronometer. See Sumner's Method, p. 363.

CHAPTER V.

CHARTS.

I. USE OF MERCATOR'S CHART. II. CONSTRUCTION OF MERCATOR'S CHART. III. PROPERTIES OF CERTAIN PROJECTIONS.

375. A CHART is a map or plan of a sea or coast. It is constructed for the purpose of ascertaining the position of the ship with reference to the land, and of shaping a course to any place.

376. In charts, the upper part, as the spectator holds it, is the north, and that towards his right hand the east, as on the compass card; latitude is accordingly measured between the upper and lower edges, and longitude between the right-hand and left-hand edges.

Parallels of latitude and meridians are drawn at convenient divisions of latitude and longitude. Compasses are described, by means of which a line can be readily drawn in any proposed direction; and the variation is marked where convenient. The depth of water, at low water springs, is denoted, as also, in some places, the quality of the bottom. The directions and velocities of currents are expressed, and on some occasions the prevailing winds are marked.*

* Charts are also constructed for special purposes, as *variation charts*, to exhibit the variation, as well as *current charts*, *wind charts*, and *ice charts*.

Caution.—In purchasing Admiralty charts care should be taken to see that they are corrected up to date. The dates of large corrections are noted on the middle of the lower edge; and of small corrections, in the lower left-hand corner of the chart.

377. Besides charts employed in general navigation, *plans* of harbours, ports, islands, or small districts, are constructed on a different scale, for reference when the ship is close in with the land. On these plans are inserted, besides the above particulars, the leading marks for channels or for avoiding certain dangers, anchorages, places convenient for landing, and for watering, with numerous other details proper to maps. Plans of these kinds are often inserted, for convenience, in a corner of the general chart.*

378. As the surface of the globe is round, while that of the paper is flat, every chart exhibiting any extent of surface is necessarily an artificial construction, or, as it is called, *projection*, of the real state of things. The charts used in navigation are those on Mercator's projection, because on this alone the track of a ship always steering the same course appears a straight line.

379. On Mercator's Chart all the meridians are parallel, and the degrees of longitude are all equal, being the same as those of the *true* difference of latitude. The degrees of latitude are unequal, being extended at each latitude beyond their proper lengths, in the same proportion as the degrees of longitude on the globe are diminished; they are consequently greater as the latitude is greater.

For Ex. the degree of lat. 60°, that is, between $59\frac{1}{2}°$ and $60\frac{1}{2}°$, is double of 1° at the equator, being increased in the ratio of the sec. lat. : 1.

I. Use of Mercator's Chart.

1. *Positions on the Chart.*

380. To find the latitude and longitude of a point on the chart.

Through the given point lay a ruler parallel to the nearest parallel of latitude, and look at what degree and minute the edge cuts the graduated meridian at the side, on which the latitude is marked. In like manner lay the ruler parallel to the nearest meridian, and see where the edge cuts the graduated parallel of latitude at the upper or lower edge, on which the longitude is marked.

Or measure, by the compasses or otherwise, the distance of the given point from the nearest parallel of latitude, and setting off this distance from the same parallel on the graduated meridian at the side, note the degree and minute there expressed.

In like manner, for the longitude, refer the point to the nearest meridian, along the graduated parallel at the upper or lower edge.

381. To find the bearing or course on the rhumb line between two places. Lay the edge of the ruler on the places, and refer it to the nearest compass.

Or, hold the thread of the horn protractor (No. 108) on one of the places, and placing the centre and the zero on a meridian, slide

* The paper on which charts are printed has to be damped. On drying distortion takes place, from the inequalities of the paper. This distortion varies greatly with different paper. It does not affect navigation; but angles taken to different points will not always agree when carefully plotted, especially if the lines to the objects be long. The larger the chart, the greater the amount of this distortion.

it with the other hand up or down till the thread covers both the places; the bearing then will be read off on the graduated edge.

382. To find the distance on the rhumb line between two places.

(1.) When the places are on the same meridian. Find, by means of the ruler, where their parallels of latitude meet the graduated meridian at the side: the Diff. Lat. they include is the distance.

(2.) When the places are on a parallel of latitude. Take one or more divisions of the graduated meridian at the parallel in the compasses, and measure with this the distance of the places; or proceed as directed in (3).

(3.) When the places lie obliquely. Take the distance between them by a pair of compasses, and lay it on the graduated meridian so as to be middled by the *middle* parallel between the places: the D. Lat. is the distance.

Of the above modes of measuring distances on the chart the first is accurate. The other two are only approximate, though near enough for common purposes.

When precision is required, the 2d case, which is Case II. of Parallel Sailing, must be solved by No. 307, 308, or 309, as the chart affords no facility. In like manner, if the places are nearly E and W., the distance should be found by Case II. of Mid. Lat. Sailing, p. 100. In the 3d case, the construction described in No. 328 must be employed. For this the chart is particularly adapted, as it shews the Mer. D. Lat. The true D. Lat. is to be taken from the scale of longitude.

383. To lay off a point on the chart in a given lat. and long. Lay a ruler through the lat. at the side, and parallel to a parallel of lat. draw a pencil line. Do the same with the longitude.

384. The course and distance of the ship on the rhumb line being given from any point, to find her place on the chart.

Lay the ruler through the given point, in the direction of the course. Take the given dist. in degrees and minutes from the graduated meridian, so that the parallel of lat. which the ship is upon shall middle it; lay off this distance along the edge of the ruler from the given point, and the ship's place is determined.

385. To lay down on the chart the position of the ship as given by observation. Lay off the given latitude and longitude as directed, No. 383.

To lay down on the chart the position of the ship by D. R., that is, by her course and distance from a given point of departure; as, for example, her place at last noon.

Lay off the course and distance as directed in No. 384.

Marking the ship's position on the chart is called pricking the ship off.

2. *Projection of the Voyage on a Great Circle.*

386. The Great Circle track between any two places may be accurately traced on a Mercator's Chart, by determining the latitudes of its points of intersection with any desired number of intervening meridians. These lats. may be computed (346), or found by the aid of Towson's Tables or Davis's Azimuth Tables (347).

387. But since the course and distance are liable to irregularities of which the Dead Reckoning can take no account, a sailing ship especially cannot be kept for any length of time upon a prescribed track; and since, when she has once deviated from the intended line, the course must be shaped anew, it is evident that the accurate projection of a proposed voyage on a great circle sometimes would be waste of labour. It will accordingly be sufficient, in general, to project the track roughly.

388. The following method by Professor Airy, for drawing on a Mercator's Chart the arc of a great circle between positions on one side of the Equator, is very simple and sufficiently accurate for practical purposes generally.

1.—Join the two points, between which it is required to project the great circle, by a straight line. Bisect this line, and from the point of section erect a perpendicular to the line on the side next the Equator, continuing it, if necessary, beyond the Equator.

2.—With the middle latitude (between the two places) enter the following table, and take out the "corresponding parallel."

3.—The centre of the arc of the great circle, required to be drawn, will be the intersection of this parallel with the perpendicular.

Middle Latitude.	Corresponding Parallel. (Opposite name to lat. of points.)	Middle Latitude.	Corresponding Parallel. (Same name as lat. of points.)
20°	81° 13′	58°	4° 0′
22	78 16	60	9 15
24	74 59	62	14 32
26	71 26	64	19 50
28	67 38	66	25 9
30	63 37	68	30 30
32	59 25	70	35 52
34	55 5	72	41 14
36	50 36	74	46 37
38	46 0	76	52 1
40	41 18	78	57 25
42	36 31	80	62 51
44	31 38		
46	26 42		
48	21 42		
50	16 39		
52	11 33		
54	6 24		
56	1 13		

N.B.—If greater accuracy is required the curve of the Great Circle should be drawn by the methods of Godfray, Towson, or by computation.

389. Godfray's Great Circle Chart and Course and Distance Diagram answer all the conditions of great circle sailing as completely and as simply as Mercator's Chart does for sailing on a Rhumb. The track is a straight line which may be drawn and examined; then the various courses and the distances to be run upon each course are obtained, as also the distance from the ship to her destination, by a mere inspection of the diagram.*

3. *Figures of Different Tracks.*

390. The track of a ship by Mercator's or by Middle Latitude Sailing, appears, as before stated (No. 378), a straight line on Mercator's Chart, on which the meridians and parallels of latitude are represented as straight lines. But on the globe such a course, unless it be N. or S., is really a *spiral*, winding towards one of the poles, which it can never reach. A ship's keel cannot pass over a point which is kept at any angle on the bow.

* *See* Chart to facilitate the practice of Great Circle Sailing, with accompanying Diagram for the determination of Courses and Distances: by Hugh Godfray, Esq., M.A. Sold by J. D. Potter, 145 Minories, London, E.

The track by Parallel Sailing, on a circle on which the ship always maintains the same distance from the pole, also appears a straight line upon the chart.

The track by Great Circle Sailing, except when on a meridian, appears on Mercator's Chart as a curve line. It may at first seem inconsistent that a curve line can, in any case, represent a shorter distance than a straight line; but every point of this curve line is nearer the pole than a point in the same longitude on the track by Mercator: and accordingly, if we divide the curve into small portions, and measure each portion as in No. 382 (2), or (3), in its own latitude, we shall find that the whole distance measures absolutely less than the length of the rhumb line joining the places.*

II. Construction of Mercator's Chart.

391. The following instructions are merely general: practice will supply details.

In N. Lat draw a line along the foot of the paper for the parallel of lowest latitude. In S. Lat. draw the line along the top. Divide this line into degrees and parts, as 30′, 15′, 10′, or 5′. Draw at the sides two perpendiculars to this line, for the graduated meridians. Find, by Table 6, the Mer. D. Lat. between the lowest parallel and 1°, or 30′, &c. above it. Take with the compasses this Mer. D. Lat. from the equally divided parallel, and set it off from this line on the meridian to be graduated. Find, in like manner, the Mer. D. Lat. between the said parallel and 2°, or 1°, &c. above it. In this way the meridians are graduated.

Parallels and meridians being drawn at convenient intervals, and the points of the coasts laid down, the coast-line is filled in by hand.

III. Properties of Certain Projections.

392. Since a small portion of a globular surface may be considered, in a practical sense, as a plane, charts of coasts, and maps of

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* In order to verify, on a globe, the results of calculations relating to the great circle and the rhumb line, the latter must be projected on the globe. To do this, note on the chart the latitude and longitude through which the rhumb line passes, at each 4° or 5°, or less, according to the degree of precision required; then lay off these points on the globe, in their several lats. and longs. by means of the moveable meridian. A curve traced by hand through the points laid off will represent the rhumb line nearly enough.

If the rhumb line between any two places, differing considerably in latitude and longitude, be produced on the chart, and transferred thus to the globe, its spiral figure will be distinctly perceived.

districts of limited extent, constructed from a scale of equal parts, exhibit, like the plan of a building or an estate, the relative *directions* and *distances* of the places upon them very nearly. On this projection, divisions of latitude and longitude may be laid off in their due proportions by means of parallel and perpendicular lines, drawn at proper distances. In drawing these lines the minute or mile of latitude is taken as the unit of measure (Nos. 186, 199), and the parallels of latitude drawn through certain divisions. The length of a minute of longitude being to that of a minute of latitude as the cosine of the latitude to the radius, is determined by No. 304, 305, or 306. On a small portion of the surface the minutes of longitude are nearly equal, and the meridians are therefore drawn parallel; but if the extent of latitude be increased, the meridians will converge sensibly towards the polar side of the chart (No. 194, note *) and the character of the projection changes.*

393. On Mercator's Chart the figure of each small district or portion of surface is truly represented, as in No. 392 above; but, as the mile or minute of latitude, which is the unit of measure, is of a different magnitude in every different latitude, if we take a greater extent of latitude we introduce a new scale of measurement. A small island, for example, near the pole, is represented, in regard to its shape, as truly as another near the equator, but on a larger scale: hence, though each small portion is truly figured, portions in different latitudes cannot be directly compared. The appearance of distortion of the countries on Mercator's Chart arises, therefore, from the distances in each latitude being drawn to a different scale.

This projection represents, with perfect accuracy, the relative positions of places as respects a rhumb line; it does not, however, exhibit the relative distances between places, which, when required with precision, must be found by the proper construction, No. 328.

The projections here described become identical at the equator.

394. Every bearing, obtained either by means of the magnetic needle or astronomical observation, is a horizontal angle on the surface of the sphere, formed at the eye, and contained between the meridian of the observer and a line drawn from the eye to meet a plumb-line passing through the point set. Such angle is the same thing as the course on a great circle. Hence observed bearings are never, unless due N. or S., or E. and W. on the equator, identical with bearings taken from Mercator's Chart. The difference is not, indeed, perceptible on common occasions, on account of the smallness of the portion of the sphere within the view of the spectator; but in charts of high latitudes, graduated with much precision, it becomes manifest, and must be taken into consideration when it is

* In the *Plane Chart* the degrees of latitude and longitude are all made equal. This projection represents very nearly the relative directions and distances of places near the equator, and serves for plans of ports and seas in those regions; but in higher latitudes it exhibits truly no directions but E. and W., N. and S., and no distances but those on a meridian. Hence the figure of every portion of surface, however small, is distorted. These charts are no longer used.

required to employ the observed bearing of a distant mountain for any purpose in which precision is necessary.*

A distant object cannot, accordingly, be correctly laid down on the chart, from its observed bearing and distance, except in low latitudes; it must therefore be laid down in lat. and long. as determined by Spherical Trigonometry. The line drawn from the observer's place to this position laid down is then the bearing on the chart,—not the *direction* of the object, but the course which a ship must preserve in approaching it while crossing all the meridians at the same angle.

It follows, in like manner, that three objects which lie in the same great circle (not the merid. or the equator), and therefore, when seen in a certain direction, appear in one, form, on the chart, an elongated triangle, the middle object of the three being on the polar side of the line joining the extremes. Thus the summit of Mount Athos, which lies a little (0′ 39″) to the N. of the great circle passing through Mount Olympus and the summit of Imbros, appears, on the chart of the Archipelago, nearly 2′ to the N. of the straight line joining the two latter places.

395. The bearing of a distant object, as taken from the chart or computed by Mercator's or Mid. Lat. Sailing, may be converted, approximately, into the true azimuth, as it would be observed, thus:—

Find half the Diff. Long. between the place of observation and the object, and also the Mid. Lat. between them.

To the log. sine of half the D. Long. add the log. sine of the Mid. Lat.; the sum is the log. sine of the corr. required. Apply the corr. to the N. in N. Lat, and to the S. in S. Lat.

Ex. The observer in N. lat. 40° 2′ sees a peak in lat. 40° 9′ N., and 1° 54′ W. of him: required the true azimuth, as deduced from the rhumb course?

The Course by Mercator's Sailing, is N. 85° 26′ W.

D. Long. 114′, half do. 57′	sin. 8·2196	Rhumb bearing	85° 26′
Mid. Lat. 40° 5′	sin. 9·8088	Sub.	37
Corr. 37′	sin. 8·0284	TRUE AZIM.	84 49

CHAPTER VI.

SOUNDING.

396. SOUNDING is ascertaining the depth of the water. This is commonly done by a lead attached to a line marked at certain divisions.

* This point, and also some considerations relative to the projection of the great circle on Mercator's Chart by rectangular co-ordinates, are treated in the "Traité de Géodésie à l'Usage des Marins," par P. Bégat. Paris, 1839.

397. The soundings marked on the chart are taken at low-water spring-tides; the depth is noted in fathoms, and, in small depths, in feet, and the nature of the bottom is specified. The "low water" of the charts is, generally, the *average* of the spring low water.*

Since the ship's place on the chart can thus be determined, within certain limits, by the soundings, it is always a proper precaution, however correctly the reckoning may be kept, to sound on approaching the land. In like manner, in a fog or during the night, the navigation is often made to depend upon the lead alone.

398. Two leads are employed for sounding, the *hand-lead* weighing 14lbs. and attached to about 25 fathoms of line, and the *deep-sea lead*, weighing 28lbs. and attached to 100 fathoms or more of line wound on a reel. A small lead of five or six pounds is sometimes used. The quality of the bottom is ascertained by fixing a lump of tallow, called the *arming*, on the lower end of the lead before it is thrown into the sea.

399. In using the hand-lead, the leadsman, standing at the vessel's side, or in the channels, throws the lead as far forward as he can, swinging it once or even twice over his head to give it increased force, and endeavours to draw the line tight from the lead at the instant the ship by her progress places him perpendicularly over it. The hand-lead descends about 10 fathoms in the first six seconds, according to some trials made by Capt. Bullock; hence, when the vessel is going fast, it is often difficult to get soundings.

The line is marked at 3, 5, 7, 10, 13, 15, 17, and 20 fathoms.† These depths are called *marks*, and the intermediate ones *deeps*; for example, in obtaining 10 fathoms the leadsman cries, with a peculiar song, "By the mark ten;" in 9 fathoms he cries, "By the deep nine." On some occasions the leadsman describes the bottom as hard or soft.

The only fractions of a fathom used are a half and a quarter; thus, $7\frac{1}{2}$ fathoms are called, "And a half seven;" $7\frac{3}{4}$ fathoms are called, "A quarter less eight."

400. In heaving the deep-sea lead, the lead is carried to the fore part of the ship, as the weather cathead or fore-chains, or the lee cathead, if the ship is making much leeway, the line being passed along outside. The ship's way being reduced when necessary, the lead is dropped and the soundings are observed by an experienced seaman at the quarter. The deep-sea line is marked at each 10 fathoms by the corresponding number of knots, and with a single knot at each five. The error of the soundings is generally in excess, because the line can rarely be stretched straight from the lead.

401 In sounding in deep water in small vessels, which drift to leeward rapidly upon losing their way, it is generally advisable to drop the lead before the headway ceases, and to cause the vessel to

* As this average height is not indicated by nature, the seaman should bear in mind that the water may, under the influence of strong winds, fall quite a foot below this average.

† These divisions require to be measured or rectified from time to time; when this is done, the line should be thoroughly wetted.

gather sternway so as to pass over the lead, which will thus have descended through a considerable depth perpendicularly.

402. The interruption to the voyage, and the inconvenience of rounding the ship in order to allow time for the deep-sea lead to descend to the bottom, have led to the invention of instruments for sounding without stopping the ship's way.*

Burt's buoy and nipper is a simple and well-known instrument. The line being rove through a spring-catch in the buoy, the lead is hove, and the buoy afterwards dropped into the water; the line then continues to run through the catch till the lead reaches the bottom, or is checked by a pull, when the catch firmly seizes the line, attaching the buoy to it at the depth descended through by the lead.

Massey's machine registers the depth by wheelwork set in motion by a fly.—Ericcson's machine measures the depth by the space into which the contained air is compressed.

Sir W. Thomson's Sounding Machine consists of a drum on which is wound about three hundred fathoms of steel pianoforte wire. This is kept at intervals between the casts in a box filled with lime water, which entirely protects the wire from rust.

A brake, partially self-acting, is arranged by a cord round a groove in the circumference of the drum, with two weights attached, one of lead (3 lbs.), the other a long iron weight (56 lbs.).

When ready to take a sounding, the brake is released by holding up the heavy weight and allowing the small one to hang freely in a recess in the heavy one. This opposes a slight resistance to the wire when running out, and when the sinker reaches the bottom the brake is put on by easing down the heavy weight gradually until it is supported by the small one.

Between the sinker (which is of iron, with a hollow at the bottom to receive the arming of tallow) and the depth gauge there is a two-fathom length of *plaited* rope, and the same between the depth gauge and the wire. It is important that *plaited* rope should be used, *not twisted.*

The depth gauge consists of a brass case about 2 feet long, containing a glass tube coated inside with a chemical preparation; this tube is open at one end, and is placed in the brass case with the open end downwards. As the sinker descends, the increased pressure drives the water up the glass tube, and the height is registered by the mark made by the combination of the water and the coating of the tube; this mark, when applied to the graduated boxwood scale, shows at once the depth that has been reached. There is also a counter attached to the wheel that shows approximately the number of fathoms of wire run out.

The instructions sent with the apparatus are ample, and the use of this simple machine is easily learnt; but men should be drilled at it in fine weather, so as to be able to handle it readily in bad. An officer and two men can with ease take soundings in 100 fathoms every quarter of an hour from a vessel going at any ordinary speed.

* Recently an instrument has been introduced wherein the depth is indicated by hydrostatic pressure.

CHAPTER VII.

The Ship's Journal.

I. Keeping the Ship's Journal. II. The Day's Work.

I. Keeping the Ship's Journal.

403. As the keeping of the log or journal, in the Royal Navy and in the merchant service, is a matter strictly professional, and as no one would be intrusted with it whose experience did not qualify him to know what matters to insert and how to express them,—and, moreover, as the log-board, from which the ship's log is copied, is ruled in an established form, the following remarks are inserted merely for reference, and not as a complete description for the instruction of the learner, who must acquire this knowledge with that of the rest of his duty.

404. The time in the ship's log-book is reckoned from midnight, as civil or common time; the first hour is, therefore, 1 o'clock in the morning, and the hours are carried on to 12, or noon, and then to 12, or midnight. The log-board, however, is copied into the log-book each day at noon.*

405. At noon, if the ship is in sight of land, a point or object of known latitude or longitude is set, and its distance estimated. This method of taking a Departure, which, from its convenience, is in general use (No. 349), is sufficiently accurate when the ship is very near the land; but when the land is distant, or enveloped in haze, and when, in consequence, the estimation of distance is liable to great uncertainty, some other method should, if practicable, be adopted in preference, or at least employed as a check. If there is no particular object in sight, the extremes of the land are set; and thus, in case of a fog coming on, the ship is secured, by keeping outside of the bearings of these extremes, from approaching the land.†

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* The log-board, on which were painted the necessary divisions, and the record made in chalk, has long passed away. A log-slate or deck log-book is kept instead.

† Since, when the ship is in sight of land, her place is determined with reference to the land alone, it is customary, during this time, to discontinue heaving the log, and therefore to omit the insertion of the courses and distances on the log-board. It is sometimes, however, proper to keep up the account when in with the land, as it affords the means of discovering a permanent current, or the direction, strength, and time of change of the tide-current.

If the ship is out of sight of land, the Course and Distance made good in the last 24 hours, the Latitude and Longitude by Dead Reckoning, as also by Observations if they are obtained, are inserted, together with the Bearings and Distance of the port or of the land worked for.

406. It often happens, from change of long., that the day of 24ʰ has expired before the sun has attained the meridian. In this case, the hours having been truly measured, and the hourly distances rightly assigned, the reckoning is truly registered up to the running out of the last glass, and an increased distance must therefore be marked against the last hour or half-hour.

In like manner the day may really have expired by observation before the 24 hours are completed. In this case a diminished distance must be marked at the last hour or half-hour.

407. The Leeway should always be marked on the log-board, since it is impossible for any one to know what leeway the ship may be making in bad weather when he is not on deck.

408. At the end of every watch, at the close and dawn of day, and at the coming on of a fog, the land is set; so that, in case of losing sight of it, a Departure may always be secured at the latest period.

409. The Weather is described at the end of each watch, or oftener, as occasion may suggest. In order to mark the strength of the wind, and the description of the weather, with more distinctness than the terms in general use among seamen are capable of expressing, Sir F. Beaufort has proposed the following system of numbers and letters, which has been adopted by order of the Lords Commissioners of the Admiralty, dated Dec. 28, 1838, in Her Majesty's ships:—

FIGURES *to denote* the FORCE OF THE WIND.

0 — Calm.		
1 — Light Air	Or, just sufficient to give steerage way.	
2 — Light Breeze	Or, that in which a well-conditioned man-of-war, with all sail set, and clean full, would go in smooth water from......	1 to 2 knots.
3 — Gentle Breeze ...		3 to 4 knots.
4 — Moderate Breeze		5 to 6 knots.
5 — Fresh Breeze	Or, that to which she could just carry in chase, full and by	Royals, &c.
6 — Strong Breeze		Single-reefed topsails and top-gallant sails.
7 — Moderate Gale....		Double-reefed topsails, jib, &c
8 — Fresh Gale.........		Triple-reefed topsails, &c.
9 — Strong Gale		Close-reefed topsails and courses.
10 — Whole Gale	Or, that with which she could scarcely bear close-reefed main-topsail and reefed foresail	
11 — Storm	Or, that which would reduce her to storm-staysails.	
12 — Hurricane	Or, that which no canvas could withstand.	

Letters *to denote* the State of the Weather

b—Blue sky; whether with clear or hazy atmosphere.
c—Cloudy; but detached opening clouds.
d—Drizzling rain.
f—Foggy—ḟ, Thick fog.
g—Gloomy dark weather.
h—Hail.
l—Lightning.
m—Misty hazy atmosphere.
o—Overcast; the whole sky being covered with an impervious cloud.
p—Passing temporary showers.
q—Squally.
r—Rain; continued rain
s—Snow.
t—Thunder.
u—Ugly threatening appearance of the weather.
v—Visibility of distant objects, whether the sky be cloudy or not.
w—Wet dew.
.—Under any letter indicates an extraordinary degree.

By the combination of these letters, all the ordinary phenomena of the weather may be recorded with facility and brevity. Examples:—b c m, Blue sky, with detached opening clouds, and a misty atmosphere. g v, Gloomy dark weather, but distant objects remarkably visible. q p d l t, Very hard squalls with passing showers of drizzle, and accompanied by lightning with very heavy thunder.

410. When a heavy sea is running, or when a swell rises without corresponding wind, the circumstance is noted.

A swell is named after the point of the compass *from* which the waves proceed, like the wind that produces them. To denote, however, a south-westerly swell (for example) as "a swell from the S.W" removes all ambiguity.

411. The variation of the compass, when observed, is inserted in the remarks; as also the results of occasional observations, as the latitute by double altitude, by the moon, planets, or stars, the longitude by lunar, &c., the exact time of observation being specified.

412. In general, besides the details proper to the particular service on which a vessel may be employed, all matters relating to her *place* are inserted in the log, not only for the safety or convenience of the present voyage, but as matter of intelligence or of evidence in the case of future inquiry. Hence the circumstance of seeing or speaking a vessel is always noticed.

No form of log has been universally adopted in merchant-ships, but several neat forms are in common use. The precise form is not material, as long as the ship's proceedings are exactly and conveniently recorded.

A separate journal, called in the Royal Navy the engine-room register, is generally kept in steam-ships. In this is recorded the revolutions of the engines, the pressure of steam, the consumption of fuel and other materials, the temperature of the engine-room, stoke-holes, coal-bunkers, &c. Generally, it is a record of all matters relating to the performance and state of the engines, and the employment of the engine-room staff.

413. The following is the form in which the logs of her Majesty's ships are at present kept by order of the Board of Admiralty, 1879.

H.M.S._______________, ______ day of ____________, 18 .

From _______________, to _______________, or at _______________.

Initials of Officer of Watch	Hours	Knots	Tenths	Standard Compass Courses	Leeway, Points	Winds		Weather	Deviation of Standard Compass	Height of		Temperature of Sea	Remarks
						Direction	Force			Bar.	Ther.		
	1												A.M.
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												

Course — Current —	Distance		Latitude —	Longitude —	Variation allowed —	Water Remains —	True Bearing and Distance	No. on Sick-list —
	made good	through the water	DR.	DR.		Daily Expendre —		
	miles	miles	Obs.	Chro.		Distilled since yesterday		

Hours												Remarks
1												P.M.
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												

Signals {

Coal expended during 24 hours { For engines / For ship / For distilling

II. The Day's Work.

417. This is the process of finding the place of the ship, with reference either to her place at yesterday's noon, or to a departure taken since, and comprises,

1st, The Course and Distance made good;

2d, The Lat. and Long. in;

3d, The Bearing and Distance of some port, which is either to be steered for directly, or is an intermediate point of land, with reference to which the course is to be shaped, so as to make it or to avoid it.

418. To work a day's work. (1.) Take the courses, with the distance run on each, from the log-board.

When a departure has been taken, consider it is a course and distance in the *opposite direction*.

Correct each course for deviation of the compass, 229, or p. 159.

If the variation has changed since the departure was taken, correct each course separately, No. 221; if not, defer this correction.

Every course affected by leeway must be corrected accordingly. The quantity, if not marked on the board, must be estimated from the circumstances. When the ship is on the *starboard* tack, allow the leeway to the *left*; when on the *port* tack, allow it to the *right*, the observer being supposed in the centre of the compass. When the ship is hove-to, take the middle point between that to which she comes up and that to which she falls off, for the compass course, and correct this for leeway.

(2.) Having corrected the Courses thus far, take out to each the D. Lat. and Dep. from the Traverse Table, and find the Course and Distance made good by Traverse Sailing, No. 287, or by Traverse Tables (Table I.)

If the variation has not been allowed for, apply it to the resulting course, No. 221.

(3.) Apply the D. Lat. to Lat. left: the result is Lat. in, No. 190.

With the Lat. left and Lat. in, and the Course, find the D. Long. by Case I. of Mid. Lat. or Mercator's Sailing (No. 315 or 323), or by Traverse Table. If the Course is due E. or W., then proceed by Case I. of Parallel Sailing (No. 304) or by Traverse Table.

Having the Long. left and Diff. Long., find the Long. in, No. 196.

(4.) Having now the Lat. and Long. of the ship, and those of the port to be worked for, find its Bearing and Distance; if in the Lat. of the ship, by Case II. of Parallel Sailing, No. 307; otherwise by Case II. of Mid. Lat., or Mercator's Sailing, No. 318 or 326; or by Traverse Table. To this Bearing apply the Variation and Deviation of the Compass, and so obtain from the True Course, the *Course to be steered.*

To find the Course on a Great circle, *see* No. 337 or 338.

It is mere waste of time to work the Course nearer than to the whole degree; for even if the compass could be depended upon to 1′, the ship cannot generally be steered within that quantity.

Ex. 1. The ship while hove-to for the first two hours, with light north-easterly winds, came up to E., and fell off S.S.E.; taking S.E. by E. as the middle course, allowing 2 pts. leeway, and 3 miles distance, gives S.E. by S. 3 miles, after which the courses and dists. follow as below. Lat left 29° 26′ N., long. left 127° 42′ E.: var. 3° E.: find the Lat. and Long. in; also set of current in the 24 hours. Position by observation being Lat. 27° 55′ N., Long. 128° 43′ E.

Courses.	Dist.	N.	S.	E.	W.
S.E. by S.	3		2·5	1·7	
S.S.E. ½ E.	23		20·3	10·8	
S.S.E.	49		45·3	18·8	
S. by E. ½ E.	24		23·0	7·0	
S. by E.	6		5·9	1·2	
S.W. by S.	8		6·7		4·4
S.W.	7		4·9		4·9
S.W. by W.	7		3·9		5·8
W. by N.	5	1·0			4·9
S. ½ E.	6		6·0	0·6	
		1.0	118·5	40·1	20·0
			1·0	20·0	
			117·5	20·1	

The D. Lat. 117·5 and Dep. 20·1 give Course by Compass S. 10° E. Dist. 119 miles.

Applying 3° (var.) to the right gives Course S. 7° E. true. Then 7° and Dist. 119 give D. Lat. 118·1, and Dep. 14·5.

D. Lat. 118	1° 58′ S.
Lat. left D.R.	29 26 N.
Lat. in, D.R.	27 28 N.

Lat. left 29° and Lat. in 27° give Mid Lat. 28°.

Then 28° and D. Lat. 14·5 give Dist.	16′ E.
Long. left	127 42 E.
Long in, D.R.	127 58 E.

To determine approximate current see Nos. 290 to 297, and 1015.

Position by Obs. Lat. 27° 55′ N., Long. 128° 43′ E.
Position by D.R. Lat. 27 28 N., Long. 127 58 E.
27   45

In Lat. 28° Diff. Long. 45 = Dep. 39·7.

Then D. lat. 27 and Dep. 39·7 gives Course N. 50° E., Dist. 48 m., set of Current in 24 hours.

Probable; the ship being in the Kuro Siwo, or Japan Stream.

In the foregoirg example, the deviation of the compass has not been mentioned. From what has been said in Chapter II. it must be evident that the bearing taken for departure and the courses steered must be corrected for deviation, where there is any. As the deviation changes when the direction of head is changed, it is obvious that each course must be corrected separately.

To correct the Compass for Variation or Deviation.

Course by Compass given.	*True Course given.*
If Var. or Dev. East, allow to right.	If Var. or Dev. East, allow to left.
If Var. or Dev. West, allow to left.	If Var or Dev. West, allow to right.
Will give true course.	Will give magnetic course.

To Correct the Compass Courses.

Easterly Variation or Deviation is + to all points between N. and E.......S. and W.
Westerly Variation or Deviation is − from all points between N. and E....S. and W
Easterly Variation or Deviation is − from all points between N. and W....S. and E.
Westerly Variation or Deviation is + to all points between N. and W.......S. and E.

To Convert a True Course or a Correct Magnetic Course into a Compass Course.

Easterly Variation or Deviation is − from all points between N. and E....S. and W.
Westerly Variation or Deviation is + to all points between N. and E.......S. and W.
Easterly Variation or Deviation is + to all points between N. and W.......S. and E.
Westerly Variation or Deviation is − from all points between N. and W....S. and E.

In the following examples the Deviations from table of No. 227 have been applied to the Compass Courses, to obtain the Correct Magnetic Courses.

Ex. 2. The Departure is taken from the Eddystone, bearing N.N E. 12 miles. Ship's head S. by E. The ship ran S. by E. 14 (miles), S. by W. 10, and S.W. by W. 8. Allow 25° westerly variation. Find the Bearing and Distance of Ushant, and Course to be steered.*

The Departure gives a Course S.S.W. (No. 418 (1)). Correcting this and the other Courses from the Deviation Table, No. 227, S.S.W. becomes S. 18° W. (No. 228), S by E. becomes S. 16° W., S. by W. becomes S. 6° W.; and S.W. by W. becomes S. 50° W.

Compass Courses.	Dists.	Correct Magnetic Courses.	N.	S.	E.	W.
S.S.W.	12	S. 18° W		11·4		3·7
S. by E.	14	S. 16 E		13·5	3·9	
S. by W.	10	S. 6 W.		9·9		1 0
S.W. by W.	8	S. 50 W.		5 1		6·1
				39·9	3 9	10 8
						3·9
						6·9

D. Lat. 39′ 9 and Dep 6 9 give Co. S. 10° W., DIST. 41. Applying 25° to the left gives COURSE S. 15° E. true. Then Course 15° and Dist. 41 give D. Lat. 39 6 and Dep. 10 6.

Then Course S. 34° W. + Var. 25° W. gives S. 59° W. + Deviation 7° W. give S. 66° W., COURSE to be steered for Ushant.

Eddystone Lat.	50° 11′ N.	
D. Lat.	40 S.	
LAT. IN, D.R.	49 31 N.	

Lat. left 50° and Lat. in 49½° give Mid Lat. 50°.

Then 50° and 10 6 as D. Lat. give Dist. 16′, the D. Long.

Eddystone Long.	4° 16′ W.
D. Long.	16 E.
LONG. IN, D.R.	4 0 W.

Lat. in 49° 31′ Long. 4° 0′
Ushant 48 29 5 4
1 2 = 62′ 1 4 = 64′
Mid. Lat. 49°.

Course 49° and Dist. 64 give D. Lat. 42; this, as Dep. and D. Lat. 62, give BEARING S. 34° W., DIST 75 m.

N.B.—On this Course allow for CHANNEL TIDES.

Ex. 3. A ship from lat. 0° 5′ N., and long. 0° 17′ W., sails S.W. by S. 7 miles, S. by E. 22, S.S.W. ½ W. 8, and N E. by E. 20. Var. 19° W. Position by Obs. Lat. 0° 15′ S., Long. 0° 20′ W. Find Compass Course to be steered,* and the Dist. to C. Palmas; also current experienced in the 24 hours.

Compass Courses.	Dists.	Correct Magnetic Courses.	N.	S.	E.	W.
S.W. by S.	7	S. 29° W.		6·1		3·4
S. by E.	22	S. 16 E.		21·1	6·1	
S.S.W. ½ W.	8	S. 23 W.		7·4		3 1
N.E. by E.	20	N. 70 E.	6 8		18·8	
			6 8	34 6	24·9	6·5
				6 8	6·5	
				27·8	18 4	

D. Lat. 27·8 and Dep. 18·4 give Co. S. 33° E., DIST. 33 miles. Applying 19° var. W. to the left, gives COURSE S. 52° E. true. Then Course 52° and Dist. 33 give D. Lat. 20·3 and Dep. 26.

To determine approximate Current, see Nos. 290 to 297, and 1015.

Lat. Obsd. 0° 15′ S.	Long. 0° 20′ W.
Lat. D.R. 0 15 S.	Long. 0 9 E.
Approximate CURRENT West	29 m.

Lat. from	0° 5′ N.
D. Lat.	0 20 S.
LAT. IN, D.R.	0 15 S.

Near the equator Dep. is D. Long., No. 311; hence,

Long. from	0° 17′ W.
D. Long.	26 E.
LONG. IN, D.R.	0 9 E.

By Obs.
Lat. 0° 15′ S. Long. 0° 20′ W.
C. Pal. 4 22 N. 7 44 W
4 37 = 277′ 7 24 = 444

D. Lat. 277 and Dep. 444 give Course N. 58° W., and Dist. 523 miles; COURSE, N. 58° W. Then
− Var. 19° W. = N. 39° W.
− Dev. 8 W. = N. 31 W.,
Compass Course to be steered.

N.B.—On this course allow for crossing the EQUATORIAL and GUINEA CURRENTS.

* In shaping the Course, consider the direction and force of the tide or current that may be found, between the position of the ship and the port steered for.

NAUTICAL ASTRONOMY.

CHAPTER I.

Definitions.

419. This branch of the subject, as already defined under the head Navigation, No. 179, relates to finding the place of the spectator on the surface of the earth by observation of the heavenly bodies.

420. To the spectator at the surface of the earth the heavens appear to form a vault, or the upper half of a hollow sphere, of which he is the centre; the earth itself, or the ground or sea on which he stands, occupying the lower half. Any two points on the apparent concave or celestial surface, as two stars, for example, may be supposed to be connected by an arc of a circle drawn on that surface: and thus the apparent celestial sphere may be conceived to be marked with circles like the terrestrial globe.

421. The spectator stands with his feet towards the centre of the globe; that is, a plumb-line, which is vertical, passes through the spectator and this centre;* and thus the spectator always conceives himself on the summit of the globe.† Suppose him now to descend the above line to the centre, and then suppose the upper half of the earth or globe to be cut off horizontally, that is, parallel to the horizon, or perpendicular to the plumb-line. The surface of the lower half-globe, or hemisphere, so exposed, being produced on all sides to meet the concave celestial surface, is called the Rational

* The earth is here supposed to be a globe; the plumb-line does not exactly pass through the centre of the spheroid, but the difference is not worth notice here.

† This is the principle of rectifying the globe, or placing the globe to shew the relative position of the spectator and the heavens.

To rectify the globe, as, for ex., for Greenwich, in 51° N. Lat. Place the globe on a level surface, so that the broad rim, or horizon, shall be horizontal. Take hold of the brass meridian, and turn the globe round in its stand (upwards or downwards) until the N. pole is 51° above the rim.

Direct the N. point of the rim (now under the pole) to the true north. Turn the globe round its axis till Greenwich passes under the meridian; Greenwich will now be the uppermost point.

The axis of the globe now makes the same angle with the wooden horizon that the axis of the heavens (or line joining the centre and the poles) makes with the horizon of the spectator.

HORIZON. Every point of the earth's surface has thus a different rational horizon, but all these horizons have the same centre.

422. It becomes, in general, necessary, for considerations which will appear hereafter, to reduce celestial observations taken at the surface of the earth to what they would have been if taken at the centre; in the following figures, therefore, the observer is supposed to be at the centre of the earth. The dimensions of the earth are so small in comparison with the vast distances of the stars, that the above change of place of the spectator from the surface to the centre, or to any other point, would produce no change whatever in the apparent places or directions of the stars; and, accordingly, the magnitude of the earth, in drawing figures for general purposes, is neglected, the earth itself being considered as a mere point in the centre of the great sphere which circumscribes the stars. In the case of nearer bodies, as the sun and some others, and especially the moon, which, when viewed with delicate instruments, appear in different directions when seen from different points of the surface of the earth, this apparent change of place is allowed for by a special calculation. (See Parallax, No. 435)

423. The ZENITH is the point vertically over the spectator, and distant 90° from the rational horizon at every point.

The point opposite the zenith, or under the spectator's feet, on the other side of the centre, is called the NADIR.

Fig. 1.

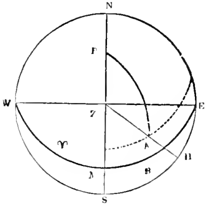
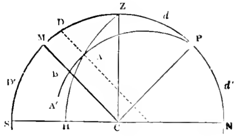


Fig. 2.



In fig. 1, N W S E represents the Rational Horizon; N S, the Meridian of the observer; N, S, E, W, the North, South, East, and West points; Z, the Zenith, which is seen directly over, or in one with the centre. This figure is drawn on the plane of the rational horizon, and shews the several circles as they would appear to an eye looking down vertically from a point at a great distance above the zenith.

Fig. 2 is drawn on the plane of the meridian, and shews the several circles of the upper or visible half of the sphere, as they would appear to the eye situated at a great distance due east of the sphere. In this figure the circle N W S E, or the horizon, appears as a straight line N S being seen edgeways; while the meridian, which in fig. 1 is the straight line N S, appears here as the semicircle N P Z S. The E and W points are seen in one with the centre.

Of these two figures, that one would naturally be preferred which would best illustrate a proposed case. Fig. 1 may generally be employed to exhibit the hour-angle and azimuth; and fig. 2 the altitude, when the celestial body is near the horizon.*

424. P, the POLE of the heavens, is the point which remains fixed, whilst the rest of the celestial surface seen above the horizon appears to revolve.

The pole P is here represented as the North pole; the other extremity of the axis round which the sphere appears to revolve is the South pole, and takes the place of P when the figure is drawn for S. Lat. This pole is called the *elevated* pole.

425. The circle E M W, 90° from the pole, is the CELESTIAL EQUATOR. The plane of the earth's equator, E M W, fig. p. 55, No. 180, being extended to the heavens, marks on the sphere the celestial equator.

426. A CELESTIAL MERIDIAN is a semicircle passing through the pole of the heavens; P Z S is the celestial meridian of the spectator. The plane of the terrestrial meridian extended to the heavens marks on the sphere the celestial meridian.

427. CIRCLES OF ALTITUDE are circles passing through the zenith, and vertical at the place of the spectator. Thus Z A H is the circle of altitude passing through a star A. Such, also, are Z M S, Z P N.

428. The PRIME VERTICAL is the vertical circle E Z W passing through the E. and W. points. In fig. 2, E Z W does not appear, being in one with C Z, a radius joining the centre and zenith.

When the observer is on the equator, the celestial equator and prime vertical coincide.

429. ALTITUDE is measured on a circle of altitude from the horizon; thus A H is the altitude of A.

The arc A H is the measure of the angle A C H, which would be formed at the centre by two straight lines, C H and C A. The alt. of a body M on the meridian is M S, which is the measure of the angle M C S.

430. *Parallels of Altitude* are circles parallel to the horizon.

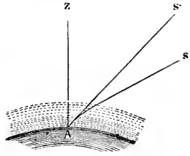
431. ZENITH DISTANCE is the arc included between the zenith and the celestial body, or the angular distance of a body from the zenith of which that arc is the measure. The zenith distance is, therefore, the complement of the altitude to 90°, as Z A.

432. The altitude of a celestial body, as seen from the surface of the earth, is called the *apparent* altitude; as seen from the centre, the *true* altitude.

A ray of light, proceeding from the body, when not in the zenith, to the eye, in traversing the earth's atmosphere, which is heavier, or denser, as it is nearer the surface, is bent more and more as it

* In like manner the figure may be drawn in the plane of the equator (as in Nos. 472, 478), in that of the prime vertical, or any other circle.

approaches the earth, towards the perpendicular direction; and as the spectator sees any object, not always in its true direction, but in that direction in which the light from it finally enters his eye, a celestial body appears higher than its true place. Thus, the ray S A, which proceeds from a star, is more and more bent towards the vertical line A Z as it approaches the surface, whereby the spectator sees the star in the direction A S′, and therefore higher than its true position.



The ray A Z, which traverses the atmosphere perpendicularly, undergoes no refraction. Thus to the eye supposed at the centre all rays would proceed without any deviation; because lines drawn towards the centre of the sphere are perpendicular to its circumference, parallel to which the atmosphere is disposed.

433. This alteration in the apparent place of a celestial body, caused by the atmosphere, is called the Astronomical Refraction.

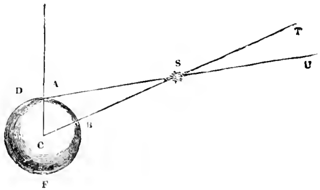
The astronomical refraction is 0 at the zenith, and about 34′ at the horizon; hence a celestial body, when really on the horizon, appears elevated 34′ above it, and is seen on the horizon when really 34′ below it. From the same cause all the celestial bodies rise earlier and set later than they would were there no atmosphere.

The refraction varies with the density or weight of the air, being greater when the barometer is high, or the air cold, and less when the barometer is low, or the air warm. The *mean refraction*, or that in the average state of the atmosphere, is given in Table 31, and corrections for different states of the air in Tables 32 and 33.

Since refraction causes the object to appear too *high*, it is to be *subtracted* from the apparent altitude in reducing it to the true altitude.

434. Twilight is the effect of the illumination of the upper regions of the atmosphere by the sun, before he has risen or after he has set, at the place of the spectator. Twilight continues, generally, while the sun is less than 18° below the horizon.

435. Parallax in Altitude is the angular depression of a celestial body, in consequence of its being seen from the surface instead of the centre of the earth, thus:



The body S, which is vertical to the spectator (who always stands with his feet towards the centre) at B, in the line C S, appears at T, being seen in the direction C S T; while to a spectator at A the same body appears below T at U, or in the direction A S U; the angle A S C, or T S U, which is equal to A S C. No. 116, is the *parallax in altitude*. (Tables 34 and 45.)

The spectator at B sees S in the same line as if he were at the centre; that is, a body in the zenith has no parallax. To a spectator at D, to whom S appears in the horizon, the depression, or parallax, is greater than at any other point.

The parallax at the horizon is called the HORIZONTAL PARALLAX.

Since parallax makes the object appear too *low*, it is to be *added* to the apparent altitude, in reducing it to the true altitude.

436. It is evident, by the fig. No. 435, that the farther off a celestial body is, the less parallax it will have; and the nearer, the more. The sun has about 9″ hor. par.: the moon has about 1°. Parallax is matter of actual observation, and determines definitively the distances of the sun, moon, and planets.

437. The parallax will obviously be less if the earth's radius is less. Now, the earth being shaped like an orange, the radius, or line from the centre to the surface, in any latitude, is less than at the equator; hence the moon's hor. par. in the Nautical Almanac, which is the *equatoreal* hor. par., is too great for any latitude. The reduction is given in Table 41.

438. Since the apparent altitude is too great on account of refraction, and too small on account of parallax, the diff. between these quantities is the diff. between the true and apparent altitudes. This difference, or the combined effect of parallax and refraction, is called the *Correction of Altitude*.

The moon's Corr. of Alt. is given in Table 39; that of a star is merely its refraction.

439. The SEMI-DIAMETER of a celestial body is half the angle subtended by the diameter of the visible disc.

Thus to a spectator at S the semi-diameter of the body is half the angle subtended by the diameter D F, or contained between the lines S D, S F, supposed to be drawn from S to D and F; the half of this angle is D S C or C S F, and is called the semi-diameter.

It is evident that the semi-diameter will be greater as the body is nearer, and smaller as it is farther off. Thus the variations in the semi-diameter of the sun prove that the distance between the sun and the earth varies at different times of the year. (Table 34.)

440. When the body S is in the zenith, it is nearer to the spectator by half the earth's diameter, C B, than when it is on the horizon; hence it appears larger when in the zenith. This increase of apparent dimensions due to increase of altitude is sensible in the case of the moon only, and is called her AUGMENTATION.* This is given in Table 42.

* The apparent increase of the magnitudes of the sun and moon when near the horizon is a mere optical illusion, whatever explanation may be given of it; for the instruments by

441. The Declination of a celestial body is the portion of the meridian between the equator and the body; it is reckoned from the equator, and is either north or south. Thus, A B, fig. 2, p. 162, is the Declin. of A, and is north.

Since the declination is measured on the celestial meridians, these are called also declination circles.

442. *Parallels of Declination* are circles parallel to the equator, as the dotted line through A, in both figures. p. 162.

Thus declination is reckoned from the celestial equator as latitude on the surface of the earth is reckoned from the terrestrial equator; and as both these circles are in one and the same plane, declination and terrestrial latitude correspond: that is, a star in 28° N. Decl. passes every day vertically over all places in 28° N. Lat.

443. Polar Distance is the arc of the celestial meridian between a celestial body and the pole, or the angular distance of a body from the pole. When the Lat. and Decl. are of the *same* name, the pol. dist. is the *compl.* of the Decl. to 90°, because the distance from the pole to the equator is 90°; when the lat. and decl. are of *different* names, the pol. dist. is the *sum* of the decl. and 90°. Thus the pol. dist. of A is P A; that of A′ in S. decl., fig. 2, is P A′, which is the sum of 90° and A′ B.

444. The Azimuth of a celestial body is the angle at the zenith contained between the meridian of the place of the spectator and the circle of altitude passing through the body. It is reckoned to begin from that part of the meridian which is on the polar side of the zenith, that is, from the N. in north latitude; thus, the angle P Z A is the azimuth of A.

The angle M Z A is the supplement of the azimuth to 180°. This is often used for convenience; thus, instead of N. 132° E., we say S. 48° E.

445. The angle N Z A or P Z A is the same thing as an angle N C H on the horizontal plane, contained between the north and south line C N, and a line from the eye at C to the foot of the circle of altitude H,* which is the "point of the compass" on which A is seen. Now the angle N C H is measured by the arc N H; the azimuth, accordingly, is measured by the arc of the horizon between the meridian of the place and the circle of altitude of the body. The ship's course is the azimuth of the ship's head; so, also, the bearing of an object is its azimuth; and difference of bearing is difference of azimuth.

When a body is on the prime vertical, its azimuth is 90°.

Since refraction and parallax take place vertically, they do not affect the azimuth of a body.

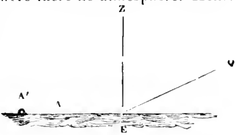
446. The Amplitude is the arc of the horizon between a celestial body at rising or setting and the E. or W. point, and is the com-

which the angles subtended by the discs are measured discover no change of magnitude. The constellations, as the Great Bear, Orion, &c., appear in like manner, when near the horizon, to occupy a vast space in the heavens, but when near the zenith much less.

* This cannot be distinctly represented to the eye by figs 1 and 2, because in fig. 1 the points Z and C coincide, and in fig. 2 the horizon N W S E appears as a straight line.

plement of the azimuth; thus E H is the amplitude of a body rising at H. Amplitude is reckoned from the E. or W.; thus, if E H is 27°, the amplitude of H is E. 27° S.

(1.) The great refraction at the horizon affects sensibly the apparent amplitude. Thus, suppose the spectator in north lat. facing the east, E Q part of the equator, E Z part of the prime vertical, A′ a star having north decl. then E A′ is the *apparent* amplitude at the instant of rising; but the star is known to be raised, that is, brought into view, in this case, by refraction, and therefore has not yet, in its revolution, arrived at the horizon; A′ is consequently to the *left* of the place A, where it would rise were there no atmosphere. Hence the arc A′A is applied to the right of the compass-bearing on which A′ is observed, in order to correct the apparent place of the star for the effect of refraction. This quantity is given in Table 59 A.



In facing the west the line E Q (which would become W Q) would lie on the other side of the prime vertical, and the star would be seen to set to the *right* of its true place.

In south lat. the figure drawn above answers to setting, putting W. for E.

(2.) As the elevation of the observer depresses the sea-horizon while it does not affect the place of the star, it produces a further effect of the same kind as that of refraction.

In the case of the moon, as her parallax exceeds the refraction, the opposite effect is produced; that is, when she appears to rise, she has already, to an eye at the centre, passed the rational horizon: thus A would be the apparent place of the moon at rising, to the *right* of the true place A′.

447. The latitude, or distance of the observer from the equator, is measured, on the celestial sphere, by the distance of his zenith from the celestial equator; or Z M is the measure of the latitude, figs. p. 162.

Suppose now D, a star of N. decl., on the meridian at D., then M D is its decl. and Z D its zenith distance; here Z M, the Lat., is the *sum* of the decl. and zen. dist.

If D′ be a star of S. decl., Z M is the *diff.* of Z D′ and M D′.

If a star *d* be between Z and P, the lat. Z M is the difference of M *d* and Z *d*.

448. When the object is to the south of the observer, that is, when his zenith is to the north of the body, the zen. dist. is commonly called N.; when his zenith is to the south of the body, the zen. dist. is called S. In fig. 2, Z D and Z D′ are therefore called North, Z *d* is called South.

It appears, hence, that when the Decl. and Zen. Dist. are of the *same* name, their *sum* is the latitude; when of *different* names, their *difference* is the latitude.

But when the star is below the pole, as at *d′*, the Lat. Z M is the Diff. of M d' and Z d', and M d' is the sum of M P and P d' or of 90°, and the compl. of the decl.

449. M Z being the lat, P Z is the Colat., since P M is 90°. Also Z N being 90°, P N is the compl. of P Z, and therefore equal to M Z; or the elevation of the pole is equal to the lat. of the place.

450. The altitude of the uppermost point of the equator on the meridian, or M S, is equal to the colatitude, because Z S is 90°. By noting this, and also that the equator passes through the E. and W. points, it is easy, in looking towards the heavens, to figure in the mind, roughly, the position of this circle. This is often useful.

451. In high latitudes, P in the figure falls near Z; in low latitudes, P falls near N. On the equator, Z and M coincide, the celestial equator there passing over the spectator's head.

In S. Lat. the letters N and S in the figures are changed; also the direction of the celestial motions (which we in N. lat. consider from left to right) is there reversed, because in S. lat., in looking towards the equator, the E. is on the right hand.

452. By the help of the preceding considerations (No. 447 and following) it is easy to construct a figure, in any case, to exhibit at once the manner in which the latitude is obtained from the meridian altitude and the declination.

Fig. 1.

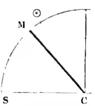


Fig. 2.

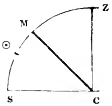
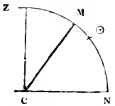


Fig. 3.



Ex. 1. The Mer. Alt. of the sun, observed to the southward, is 58°; his Decl. 14° N

Fig. 1. Draw a quadrant Z C S by means of the chord of 60° (No. 107). Lay off, by the scale of chords, the Alt. S ⊙, 58°, or the zen. dist. Z ⊙, 32°. Lay off the Decl. 14° to the *southward* of the sun, as ⊙ M, since he is to the *northward* of the equator; then M is on the equator, and Z M is the LAT. *north*, and measures 46°.

Ex. 2. The Mer. Alt. of the sun, south of the observer, is 29°; his Decl. 18° S.

Fig. 2. Lay off S ⊙, 29°, and ⊙ M, 18° to the N. of the sun; then M is the place of the equator, and Z M, the LAT. north, measures 43°.

Ex. 3. The Mer. Alt. of the sun, north of the observer, is 38°; his Decl. 14° N.

Fig. 3. Lay off N⊙, the Mer. Alt. 38°, and ⊙M the Decl. 14° to the S. of ⊙; then Z M is the LAT. south, and measures 38°.

These figures, which are varieties of fig. 2, p. 162, are of the simplest kind. The point Z being marked on the quadrant, the place of the sun at ⊙, north or south of the observer, is given by the observation; his declination gives M the place where the equator cuts the meridian; whence it is at once seen whether Z is north or south of M, that is, whether the Lat. is N. or S.*

* After a little practice the observer will perceive, at the time of observation, how to deduce the latitude from the mer. alt. and decl. independently of the distinctions of signs above (No. 448), which are adopted for the purpose of forming a general rule.

453. The passage of a celestial body over any particular point or circle is called TRANSIT; as the transit of the meridian, or the prime vertical, of a planet over the sun's disc, &c.

454. CULMINATION is another term for transit of the meridian. The transit of the meridian below the pole, whether above or below the spectator's horizon, is called the lower culmination; the other transit is called the upper culmination.

455. OCCULTATION is the disappearance or hiding of a celestial body by the intervention of another. Thus the stars in the moon's path are occulted by her, and the satellites of a planet by the body of the planet.

456. ECLIPSE is the disappearance of a celestial body in the shadow of another. In an eclipse of the moon, she disappears wholly, or partly, in the shadow of the earth, the earth being then in a line between the sun and moon. In an eclipse of the sun, the moon, being then in a line between the sun and the earth, conceals from us, for a time, the whole or part of the sun.

457. Celestial bodies are said to be in *Conjunction* when in a line together, as seen from the centre of the earth. Bodies having the same Right Ascension are said to be in Conjunction in Right Ascension (No. 469).

Two bodies are said to be in *Opposition* when in diametrically opposite points of the heavens.

458. It will be perceived, on attending to the circumstance, that stars which are visible in the west soon after sunset, disappear after some days in the solar light; and, in like manner, that stars which are faintly seen in the east, before sunrise, become more distinct from day to day. Hence the sun, besides revolving daily with the fixed stars* from east to west, has an apparent yearly motion amongst them in the contrary direction, or from west to east, completing the circuit of the heavens in the course of a year.

459. The path on which the sun appears to move, or the great circle which he seems to describe in the heavens, is called the ECLIPTIC.

460. The ecliptic is divided into twelve SIGNS, or portions of 30° each, called the *Signs of the Zodiac*, which term originally meant a space or belt of 8° wide on each side of the ecliptic, to which the planets† are confined. The signs, taken in the order in which the

* The stars are bodies which shine by their own light, and astronomers conclude, from every analogy yet detected, that they are suns. They are called "fixed," because to the eye they appear always in the same relative positions with respect to each other. The distance of the stars is so great that the difference of angular position, as seen from opposite points of the earth's orbit, a distance of a hundred and ninety millions of miles, has been found, in the case of one star only, to amount to so large a quantity as 2″, according to Mr. Henderson's determination of the parallax of α *Centauri*. At this star, therefore, the sun, which to us appears under an angle of above half a degree, would subtend an angle of only two hundredths of a second.

† The planets are bodies which, like the moon, shine by light received from the sun and reflected to us; they revolve round the sun in the same direction as the earth, but in different periods of time. Mercury ☿, the nearest to the sun, revolves in 88 days; Venus ♀, the next, in 225 days. These, moving in orbits inside that of the Earth, are called *inferior*

sun moves through them, that is, in the contrary direction to the apparent diurnal motion, are as follow:—

♈ *Aries* (the Ram).	♎ *Libra* (the Balance).
♉ *Taurus* (the Bull).	♏ *Scorpio* (the Scorpion).
♊ *Gemini* (the Twins).	♐ *Sagittarius* (the Archer).
♋ *Cancer* (the Crab).	♑ *Capricornus* (the Goat).
♌ *Leo* (the Lion).	♒ *Aquarius* (Water Bearer).
♍ *Virgo* (the Virgin).	♓ *Pisces* (the Fishes).

461. Besides this perpetual motion from west to east, the sun is always changing his declination, which varies between 23° 28′ N. and 23° 28′ S. He crosses the equator twice in the year, namely, about the 20th of March, in coming up to us in N. lat. from the southward, and again about the 23d of Sept. in going to the southward.

462. When the sun crosses the equator, he rises and sets at six o'clock in all parts of the world;* at these times, therefore, the days and nights are every where equal.

463. The two points in which the ecliptic, or sun's path, thus cuts the equator, are called the *Vernal*, or spring, *Equinox*, and the *Autumnal Equinox.*

464. The sun attains his greatest N. decl. about June 21st, and the greatest S. decl. about Dec. 22d. The points at which the sun seems at these times to be stationary in declination before he diminishes it, and at which the ecliptic and equator are most widely separated, are called the *Summer* and *Winter Solstices.*

465. As the light and heat received from the sun at any place vary with his altitude, and the time during which he remains above the horizon, and as both of these depend on the declination, the succession of seasons depends on the changes of the declination of the sun. The common or civil year, as most convenient for the affairs of life, includes the succession of the seasons. It is, therefore, the interval in which the sun leaves any parallel of declination and returns to it again, and is called a *tropical* year. Its length, that is, the average length of a number of such years, is $365^d\ 5^h\ 48^m\ 51^s{\cdot}6$, of common or mean time.†

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planets. Mars ♂ revolves in nearly 2 years; Jupiter ♃, in nearly 12 years; Saturn ♄, in 29 years; Herschel ♅, in 82 years; and Neptune ♆, in 165 years. These last are called *superior* planets. Besides these there are numerous small planets [287 known in 1890] whose orbits lie between those of Mars and Jupiter. Some of the planets have satellites, or moons: Mars has two, Jupiter four, Saturn eight, Herschel six, and Neptune one.

* The observed times differ a little from 6^h on account of refraction, No. 446.

† If the tropical year contained exactly 365 days, the arrangement of the calendar would be perfectly simple; but the necessity of counting by entire days in the affairs of life has introduced arbitrary expedients for checking the errors accumulated from time to time, from neglecting the excess over the last complete day. For example, suppose the year ends at midnight on Thursday, then new year's day begins at the same instant, that is, at 0^h on Friday morning, while the old year is really not yet out by nearly 6 hours. Next year 6 hours more of the new year will be anticipated, that is, new year's day will be reckoned 12 hours too soon; so that at the end of 4 years the beginning of the new year is anticipated by a whole day. By *adding* 1 day to the fourth year this error is removed, and the commencement of the calendar year is carried back to its true place nearly

The period of the commencement of the year, which has been adopted differently at different times, is at present (as established in this country by act of parliament) on January 1st, which is about 11 days after the winter solstice.

466. Since it is summer on that side of the equator on which the sun is, and winter on that on which he is not, the seasons in south latitude are reversed.

467. In the continual apparent revolution of the heavens round the earth, the circles of declination are perpetually describing angles round the poles, which are called, from the division of time into hours, HOUR-ANGLES.

468. An hour-angle, or horary angle (sometimes called also Meridian Distance), is the angle at the pole contained between the meridian of the place and the celestial meridian passing through the body; thus, Z P A is the hour-angle of A (figs. p. 162). An hour-angle is measured by the arc of the equator contained between the meridian of the place and that of the body; thus M B, fig. 2, measures Z P A.

The hour-angle is thus measured on the celestial equator in the same way as longitude is measured on the terrestrial equator.

469. The RIGHT ASCENSION of a celestial body is the arc of the equator included between the first point of *Aries* and the celestial meridian of the body: it is reckoned from west to east. Thus, if ♈ be the first point of *Aries*, fig. 1, p. 162, the arc ♈ M B is the Right Ascension of the body A. The 360° of the celestial equator are divided into 24^h of R.A.

Thus R.A. is reckoned on the celestial equator exactly as the longitude of places on the earth is reckoned on the terrestrial equator. But as the stars do not preserve that constant position with respect to the meridians which they do with respect to the equator, there is not that correspondence between R.A. and longitude which there is between declination and latitude.

470. The apparent revolution of the stars is perfectly regular, and is the only motion of the kind known.

One revolution of the earth round its axis, or, which is the same thing, the return of the same fixed star to the meridian after completing the circle, constitutes a *sidereal day;* this day consists of $23^h\ 56^m\ 4^s$ of common or mean time, as measured by clocks and watches. It is divided into 24 hours, called sidereal hours, and these into sidereal minutes and seconds. Thus a sidereal day is about 10^s

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But the excess above 365^d does not amount to 6^h by $11^m\ 8^s$ nearly; hence at the end of the fourth year an error of the contrary kind is introduced of $44^m\ 32^s$, which amounts to nearly 3 days in 4 centuries. This error led to the reformation of the calendar by Pope Gregory XIII., in 1582, when the vernal equinox, which at the Council of Nice, in 325, had taken place on the 21st March, fell on the 11th. Hence, leaving 10 days out of the calendar, which was effected by calling the 4th of October, 1582, the 15th, brought matters right again. The error had amounted to 11 days when the change was adopted in this country in 1751.

This error is prevented for a long period in future by the Act 24 Geo. II., which directs the leap-years 1800, 1900, 2100, and so on, to be considered as common years, and 2000, 2400, 2800 as leap-years.

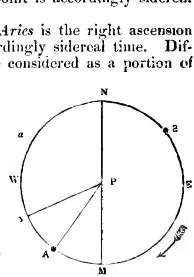
an hour shorter than a common or mean day; and the sidereal hours, minutes, and seconds, in the same proportion.

The sidereal day being thus, in round numbers, 4^m shorter than the mean day, a star that passed the meridian last night at 9 P.M will pass this evening at $8^h\ 56^m$, and so on, till after a few months it will pass at noon. (See Table 27.)

471. SIDEREAL TIME begins (that is, a sidereal clock, regulated to sidereal time, shews $0^h\ 0^m\ 0^s$) when the first point of *Aries* is on the meridian, and is counted through 24 hours, till the same point returns again; the hour-angle of this point is accordingly sidereal time.

The hour-angle of the first point of *Aries* is the right ascension of the meridian, No. 469, which is accordingly sidereal time. Difference of R.A. may, in like manner, be considered as a portion of sidereal time.

472. P is the pole, the circle N W M E the celestial equator, to which the measures of all hour-angles are referred. The bent arrow shews the direction of the apparent diurnal motion of the celestial bodies, reckoned from east to west supposing the spectator to face the south. M N is the observer's meridian.



A is any celestial body, as a star, which has passed the meridian at M, then A P M is the *hour-angle* of A, of which the arc A M is the measure.

(1.) B is a star to the eastward of the meridian, which it has passed at N; its hour-angle, reckoned westwards, is measured by M W N B. We may, however, employ also B M, the measure of the hour-angle reckoned eastwards. Thus, instead of $14^h\ 11^m$ W. we may call it $9^h\ 49^m$ E. As in dealing with hour-angles we refer directly to the number of hours which they contain, and which are measured on the equator, it is unnecessary to form the hour-angle of B by joining B and the pole.

(2.) Let the first point or beginning of *Aries* be at ♈, having passed the meridian before the star A; then ♈ M is the *right ascension* of the meridian, that is, sidereal time. The R.A. of A is ♈ A; that of B is ♈ M B, reckoned always from west to east, or opposite to the diurnal motion; and ♈ N B is the supplement of the R.A. of B to 24 hours.

(3.) The *sidereal time* ♈ M is the sum of the arcs ♈ A and A M, that is, of the hour-angle and R.A. of the star A. Again, ♈ M is the difference between the arcs *a* M and *a* ♈, that is, between the hour-angle of the star *a* and the supplement of its R.A. In the case of the star B, the sid. time is the difference between its R.A. ♈ M B, and its hour-angle M B.

Hence it is easy, when the hour-angle of a star of known R.A. is given, at any instant of time, to construct the figure to shew the sidereal time, thus:—Having drawn a circle, with the meridian, lay off, by a scale of chords, the star's hour-angle; the position of the star being now given, lay off its R.A., reckoning from the *star* in the *same direction* as the apparent diurnal motion (for thus the R.A. reckoned back again from this point ♈ will agree with the place of the star). This gives the place of ♈, the hour-angle of which, reckoned westward, is the sid. time required.*

Ex. 1. The hour-angle of a star is $2^h\,28^m$ W.; its R.A. $3^h\,47^m$.

Lay off $2^h\,28^m$, or 37°, to the W. of M, and $3^h\,47^m$, or $56^\circ\,45'$, further on towards the west: then the sid. time measures $93^\circ\,45'$, or $6^h\,15^m$.

Ex. 2. The hour angle of the moon is $9^h\,13^m$ W.; her R.A. $18^h\,34^m$.

Lay off 6^h, or 90° (No. 107), and $3^h\,13^m$, or $48^\circ\,15'$, from M, westwards. Then lay off 3 times 6^h, or 90°, and 34^m, or $8^\circ\,30'$, further: the sid. time measures $56^\circ\,45'$, or $3^h\,47^m$.

Ex. 3. The hour-angle of a star is $14^h\,11^m$ W., or $9^h\,49^m$ E.; its R.A. $5^h\,21^m$.

The sid. time is $19^h\,32^m$.

All hour-angles, which are differences of R.A. of the meridian and a celestial body, may be considered as portions of sidereal time. The *interval of time* in which a body of variable R.A. *describes* an hour-angle depends on the rate at which its R.A. changes.

473. The earth's motion round its axis being perfectly uniform, becomes the real standard of uniform measures of time; but as any star passes the meridian nearly 4^m earlier every night, the beginning of the sidereal day has no connexion with that of the common or civil day, as determined by light and darkness.

474. The hour-angle of the sun, reckoning always westward from the meridian, is APPARENT TIME. Thus, when the sun's meridian has passed over 48° of the celestial equator to the westward of the meridian of the place, it is said to be $3^h\,12^m$ apparent time. This is the time shewn by the sun-dial.

475. The interval between the sun's passing the meridian on one day and the next, or the *apparent solar day*, is not always of the same length, the difference being sometimes half a minute between one day and the next. Apparent time serves well enough in cases where this irregularity does not appear, or is of no importance; as for example at sea, where, from the continual change of longitude, the time must be obtained by observation: but where account of the time is to be kept by mechanism alone, it must necessarily be divided into portions of invariable length.

The time for general use must, accordingly, unite the two advantages of being regulated by the sun, and of being perfectly uniform. The mean or average day of 24 hours must therefore be an average taken of all the days in the year, that is, such a day as the sun would regulate if he moved uniformly in R.A. This average day is called

* In the questions which this figure illustrates, motion *round* the pole only is considered; since, therefore, the place of a celestial body on its meridian is unconnected with the motion of the meridian itself round the pole, no regard is had to declination.

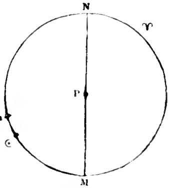
As the spectator will naturally refer the hour-angle of a star to the elevated pole of the place, in south latitude the figure will appear reversed, since the diurnal motion there appears from right to left in facing the equator. The figure, however, may be drawn in that manner which may appear the clearest, the only point essential to be kept in view, being that the R.A. is reckoned the opposite way to the apparent diurnal motion.

the *mean solar day*, and time thus regulated is called mean solar time, or Mean Time, which is that shewn by clocks and watches.

476. The sun being generally either behind or in advance of the position which he would have occupied if he had moved uniformly, mean time is in general either fast or slow, on apparent time. The correction for this irregularity, that is, the difference between the sun-dial and the mean solar clock, is called the Equation of Time. Mean time is, therefore, deduced from apparent time, by applying the equation of time. See the Nautical Almanac, p. I. or II., or Table 62.

477. The Sidereal Time at Mean Noon is the right ascension of the meridian at the instant when the sun, if he moved uniformly, would be on it.

It is evident that this element, from its nature, varies uniformly; now, since the sun's R.A. varies irregularly, and since the equation of time, which is the correction that removes this irregularity, must also vary irregularly, it follows that the unequal variations of the equation of time and the sun's R.A. are together equivalent to the single and uniform variation of the sid. time at mean noon; and herein consists the great convenience of employing the sidereal time at mean noon, which has been given in the Nautical Almanac only since 1834.*



478. (1.) Let ☉ be the place of the sun, at about 4 P.M., *m* the place where he would be if he always moved uniformly; then ☉M is *apparent time* (No. 474), *m* M is *mean time*, and *m* ☉ is the *equation of time*. The equation is here *additive* to app. time, as is the case from January to March, and from July to August. (See Table 62.)

(2.) Let ♈ be the first point of Aries; then, while the sun and ♈ revolve, the sun moves contrary to the diurnal rotation, or is always *increasing* his R.A., or the arc ♈N☉, by nearly 1° a-day. The complete revolution of ♈ constitutes a *sidereal day*; that of ☉, an *apparent solar day*; and that of *m*, a *mean solar day*.

After 24 sidereal hours the sun has still to describe about 1°, or one 360th part of the circle to complete it; the time necessary for which is about one 360th of 24 sidereal hours, or 4 sidereal minutes. Thus the solar day is longer than the sidereal day by about 4^m. The *mean solar day* being divided into 24 hours, the sidereal day is $23^h\ 56^m\ 4^s$ of such a day.

(3.) When *m* is on the meridian at M, the arc M *m* ♈, or the

* This element, which is the R.A. of a mean, or imaginary sun, is a very different thing from the R.A. of the sun *at mean noon*, with which it has been confounded: the latter can differ only a few seconds from the R.A. ☉ at *apparent noon*, but may differ from the *Sidereal Time at mean noon* by the whole amount of the equation of time, or sixteen minutes.

sun's mean R.A., is the *sidereal time at mean noon.* When m has arrived at m in the figure, this quantity has changed by an amount proportional to the mean time M m.

The ☉ moves sometimes more quickly, at others more slowly, the point m (which is merely an imaginary situation of ☉, deduced by calculation, from knowing the limits within which the irregularities of its motion are confined) moves equably. Hence m ☉, the difference of these two, changes unequally.

(4.) By No. 472 (3) the sidereal time, or place of the point ♈, is obtained from the hour-angle of any celestial body. By applying to the place of ♈ the sid. time at mean noon, we obtain the place of m, or mean time.

Thus Mean Time is found from the hour-angle of a star.

479. Since the sun m passes over 15° of the circle in one mean hour, he arrives at the meridian of a place 15° *west* of N M one hour *after* he has passed N M, that is, at one o'clock of the time at any place, or all places, of which N M is the meridian. In like manner he passes a meridian 15° *east* of M one hour *before* he arrives at M, that is, when the time on M is 11 o'clock in the forenoon, or 23 hours after the noon of the day before.

Thus the beginning of the day, and therefore the hour or time of the day, at one place differs from that of another place by the difference of longitude of the places; the time at the easternmost of the two being in advance of, that is, greater than, the time at the other. Hence when the times proper to two places at the same instant are known, their diff. long. is determined, or the relative positions of their meridians.*

480. The Civil Day is dated from midnight, and the twelve hours are computed twice over; the Astronomical Day is dated from noon, and runs through the twenty-four hours.

Ex. 1. October 3d, $3^h\ 18^m$ P.M., civil time, is the same astronomical time.

Ex. 2. January 3d, $4^h\ 25^m$ A.M. civil time, is reckoned January 2d, $16^h\ 25^m$ astronomical time.

Ex. 3. April 1st, 11 A.M. is, astronomically, March 31st, 23 hours.

481. The GREENWICH DATE is the time at Greenwich corresponding to any given time elsewhere.†

* The diff. long. is found as well by means of the motion of a star as of the sun, that is, by means of a clock or chronometer regulated to sidereal time, as well as by one regulated to mean time. For although the absolute interval of time employed by a star in moving from one meridian to the other is less than that employed by the sun, yet it is divided into the same number of hours, minutes, and seconds, but which are of smaller magnitude and thus the difference of time results, in numbers, the same.

† Here terminates all requisite description of the terms used in the rules in the present volume. The other terms which occur in the Nautical Almanac will be described in the *Theory*.

In this chapter we have sometimes spoken of the earth as fixed and the heavens as movable, although this is contrary to fact, because the appearances alone furnish us with the measures of time, without any regard to the actual state of things.

Again, we have considered the earth as a sphere instead of a spheroid (No. 180). The consequences of the oblateness, in an astronomical point of view, are that the planes of the

482. It will be found a useful exercise of what has preceded to verify the following remarks:—

(1.) No star of which the pol. dist. is less than the lat. can set, and no star of which the pol. dist. exceeds 90° *plus* the colat. (S M, fig. p. 162) can be visible.

(2.) When the pol. dist. is less than the lat. the star passes the meridian both above and below the pole.

(3.) When the pol. dist. is less than the colat. the star passes the meridian between the zenith and the pole, and does not pass the prime vertical.

(4.) When the declin. is 0, or the pol. dist. 90°, the body rises and sets in the E. and W. points. The hour-angle at rising and setting is 6^h, and the body is seen raised on the prime vertical by the effect of refraction; unless it is the moon, which, from her parallax being greater than her refraction, is not seen at the precise time of her rising and setting.

The object is above the horizon for 12 hours, and 12 hours below it.

In this case the amplitude is 0, except from the effect of refraction.

(5.) When the pol. dist. exceeds 90°, the celestial body rises and sets on that side of the E. and W. points which is farthest from the elevated pole; the hour-angle at rising and setting is less than 6^h: the time during which the body is above the horizon is less than 12 hours, while it is more than 12 hours below the horizon. The body does not pass the prime vertical above the horizon; and the amplitude is reckoned towards the S. in N. lat., and towards the N. in S. lat.

(6.) When the pol. dist. is less than 90°, the celestial body rises and sets on the same side of the E. and W. points as the elevated pole; the hour-angle at rising and setting is greater than 6^h. The body is more than 12 hours above the horizon, and less than 12 hours below it. The amplitude is reckoned towards the N. in N. Lat., and towards the S. in S. Lat.; the body passes the prime vertical twice The hour-angle at the passage of the prime vertical is less than 6^h. (See Table 29.)

(7.) A star having a certain declination always rises and sets in the same points, and passes the meridian and prime vertical, or any other circle of altitude at the same altitude, without regard to its R. A.

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circles of altitude (excepting the meridian) do not pass through the centre, and that the length of the radius, or line drawn from the centre to the place of the observer, is different in different latitudes. The first of these conditions produces no sensible effect in practice, because the Time is not affected by it, and the same Latitude (though differing from the latitude on a sphere by the quantity in Table 52) results alike from all observations, of whatever kind, of a body not affected by parallax,—and thus the oblateness, however great, would always be neglected in determining a place by observation of the stars or the sun. By the second condition the parallax of the moon is affected, and a further correction of her apparent place becomes necessary.

We have also described the first point of ♈ as fixed, whereas it has a very slow motion. The stars, also, though called fixed, have slow proper motions. These and other points not necessary to our present subject will be treated more at large in the *Theory*.

(8.) As the place of a star or any celestial body is determined by its R. A. and Decl., and as, at the place of the spectator, the position of the celestial equator, to which both these are referred, is fixed, it is easy to know whereabout any star is to be looked for at any time. When, as is commonly the case, the time (mean or apparent) is given, the sun's hour-angle is known; and therefore, when he is invisible, his place on the equator may be estimated. By means of the sun's place, and his R. A., the place of the first point of Aries may be estimated; then the star's R. A. gives the place of its meridian on the equator, and its declination the place of the star with respect to the equator. When the sidereal time is given, the place of the first point of ♈ is at once known, just as the place of the sun is known from the apparent time.*

* The position of the equator, and the relations among the Latitude of the place, the Time, and the Hour-angle, Altitude, and Azimuth of a celestial body, are best illustrated by a celestial globe. The broad horizontal rim represents the Rational Horizon (No. 421). The brass meridian of the globe being laid N. and S., and the Pole elevated, by the degrees marked on it, to the latitude (No. 449), the globe represents the celestial sphere as shewn in figs. 1, 2, p. 162. The position of the sun is found by marking the sun in his place in R.A. and Decl., by the help of the divisions on the globe, and then setting the sun at his proper hour-angle by means of the hour-circle near the pole. The Alt. or Zen. Dist. is measured by a graduated slip of brass, or by a thread, as in the note, p. 129. It is unnecessary to enter further into details, as the reader who well understands the definitions above will find no difficulty in solving any useful "problem on the globe" which can be proposed, without burdening his memory with technical rules.

In the absence of a globe, distinct ideas may be obtained of the actual positions of the celestial bodies by a circular card, as a compass-card, having the hours marked on the edge, and an axis, as a pencil, put through the centre perpendicular to the card. If this axis be laid N. and S., and the north end (in north lat.) raised up till it is inclined to the horizon at an angle equal to the latitude, it will represent the polar axis round which the celestial bodies revolve, the card representing the equator. The 0^h being brought up to the meridian, the hour of the day at the edge will shew the place of the sun's meridian at the time. If the 0^h be made the first point of ♈, the hours become hours of R.A.; if, then, the ☉ be marked on the edge, on its proper R.A., and then turned round to the position proper to the hour of the day, the place of the first point of ♈ is seen.

Suppose, now, a small telescope were placed on the axis making an angle with the plane of the equator, or the card, equal to the declination of some star, then, while this star revolves parallel to the equator, the telescope, kept at the same angle, could at any time be directed towards the star by merely turning the axis round. A large instrument is constructed on this principle, and is called an *Equatoreal.*

CHAPTER II.

Instruments of Nautical Astronomy.

I. The Reflecting Instruments.

II. The Artificial Horizon. III. The Chronometer.

I. The Reflecting Instruments.

483. These are instruments for measuring angles between two objects, by bringing the reflected image of one of them to coincide with the other seen directly. They are necessary for observing altitudes of the heavenly bodies at sea, where the spectator has no fixed point of reference except in the horizon. On shore, and often on a field of ice, the fixed point required in observing altitudes is obtained by means of the artificial horizon.

484. The instruments of this class which are in most common use are the quadrant, sextant, and reflecting-circle. For convenience, we shall describe the adjustments generally under the two former; and as every person in possession of an instrument will be instructed by the maker or some expert person in the names of the different parts, and also in the mode of handling it, and packing it in the case without danger of distortion, we shall confine ourselves merely to matters of general reference.

1. *The Quadrant and Sextant.*

485. The quadrant contains an arc of more than 45°, and measures a few degrees more than 90°; it is usually made of wood, and the graduated arc, which is ivory, reads to minutes, and sometimes to 30″. The sextant measures a few degrees more than 120°; it is made of brass, and sometimes reads to 10″. The quadrant serves for common purposes at sea, but the sextant is required for taking a lunar observation.

The observer should be in the habit of employing good instruments of their kind, as inferior instruments naturally induce careless and imperfect observation.

486. The sextant made of a very small size, and thence called the Pocket Sextant, is adapted to the use of surveyors, travellers and others, on occasions in which minute accuracy is not necessary.

[1.] *Manner of Using.*

487. To take the sun's altitude at sea. **Set the index at 0,** put down a screen before the central mirror, hold the instrument in a vertical position, and direct the sight, through the sight-vane and horizon-glass, to that part of the horizon which is exactly under the sun. Now move the index on with the left hand, and the image of the sun will appear to descend towards the horizon. Vibrate the instrument round the line of sight, and make the lower limb touch the horizon: this gives the *observed altitude of the lower limb.*

488. This last altitude is sometimes near enough; but for accuracy, having made a rough contact as above, put in the telescope, previously set to distinct vision by looking through it at the horizon; the image being now magnified, the contact is made more correctly. In general the telescope should not be fixed till a rough contact has been made, because it narrows the field of view, and increases the difficulty of bringing the images together.

The contact must be made in the centre of the field: if it is too near the plane of the instrument, or too far from it, the angle will be too great by the quantity in Table 54.*

489. When there is a tangent-screw, clamp the index, and make the contact perfect by turning the screw,—some further remarks on which will be made in the proper places.

The tangent-screw should be kept nearly middled when not in use.

490. To take the altitude of a star. Set the index to 0, direct the sight to the star, hold the instrument vertically, and move the index onwards: the image of the star will be seen to descend. This method is proper to avoid bringing down the wrong star, but should not be practised with the sun, as it exposes the eye to an intense light, which may derange it for the whole observation.

491. The shades, or coloured glasses, placed before the two mirrors, tend to equalise the brightness of the object and the image, and sometimes distinguish one from the other by the difference of colour. The shades require to be particularly well ground, because, if the surfaces are not strictly parallel, the rays in passing through the glass are turned out of their former direction: hence, when a defective shade is placed before each of the mirrors, the angle is affected by the sum or the difference of the errors due to the shades. It is advisable, therefore, in general, to employ a dark glass at the eye-end of the telescope, by which the shade before one or both of the mirrors may be dispensed with. Also, if this glass is not perfect, the rays from the object and the image are affected alike, and the angle between them remains unchanged.

A card screen, to slip over the eye-end of the telescope, is useful in protecting the eye from accidental glare.

492. The observer acquires, by attention, the power of estimating

* Mr. Hartoup, director of the observatory at Liverpool, acquaints me that he has constantly found sextant observations to come out more accurately in proportion as he narrowed the field by closing the wires.

the proper angle at which to set the index for a rough contact, and thus saves time. It also effects some saving of time to have the tubes of the telescope marked at the observer's focus.

493. When the angular distance between two objects is to be measured, the plane of the instrument is held in the line joining them, and the sight is directed to the fainter of the two. When, therefore, the brighter object is to the right, the instrument is held face upwards, and the image of the right-hand object brought to touch the left-hand object seen directly; but when the brighter object is to the left (as in observing the distance between the sun and moon in high north latitudes in the forenoon), the instrument must be held face downwards, the sight being directed to the right-hand object. The contact must be made in the centre of the field, as directed above.

[2.] *Reading off the Angle.*

494. The angle having been observed, its measure is to be read off. The arc being divided into degrees, and these subdivided into halves, thirds, &c., the smallest division contains several minutes, and the angle can thus be read, but roughly, from the arc itself.

In order to read to 1′, or a fraction of 1′, a scale called a *vernier* is applied to the arc; this is a portion of an arc having the same centre, and divided into *one part more* than an equal portion of the arc itself. The manner in which a more minute reading is obtained may easily be understood from the following example:—Suppose a division on the arc to be $\frac{1}{3}$ of 1°, or 20′, and the vernier to be equal in length to 19 divisions, or 6° 20′, but divided into 20 equal parts; then each of the divisions on the vernier is $\frac{1}{20}$ of 6° 20′ or 380′, that is 19′, and therefore the difference between one division on the arc and one on the vernier is 1′.

Suppose the beginning of the vernier and that of the arc to coincide, as in Fig. 1; then the first of the dividing lines of the vernier falls short of the first dividing line of the arc by 1′; therefore, if we make these lines coincide, we advance the vernier 1′. Again, to make the second dividing lines of each coincide, we must move the vernier through 2′, and so on.

In Fig. 2 the 0 of the vernier stands between 20′ and 40′ after the division at 3°, and the first coincidence is at 9; hence the arc measured is 3° 29′.

Fig. 1.

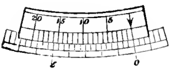


Fig. 2.

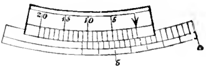
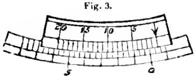


Fig. 3.



When the index is moved the contrary way, the o of the vernier goes off the arc, as seen in Fig. 3. As the 20 of the vernier stands at 6° 20′ when the two zeros coincide, if we move it 1′ to the right, the coincidence will occur at 19, and at 18 if we move it 2′, and so on. Hence, to measure an angle *off the arc*, we must read from the *end* of the vernier. The arc shewn is 32′ off the arc.

[3.] *Adjustments.*

495. (1.) The Index-Glass, or central mirror, must be perpendicular to the plane of the instrument.

Set the index about 60°; then, if the image of the arc in the mirror appear in perfect continuation with the arc itself, the adjustment is perfect; if the reflection seem to droop from the arc itself, the mirror leans back; if it rise upward, the mirror leans forward. The position is rectified (in quadrants only) by the screws on the back. This adjustment generally rests with the maker, but it should be occasionally verified by the observer.

(2.) The Horizon-Glass, or fixed mirror, must be perpendicular to the plane of the instrument.

Set the index to 0, hold the instrument horizontally, look through the glass at the sea-horizon, or other distant object, and give the instrument a small nodding motion: then if the reflected image appear neither above nor below the real object, the adjustment is perfect; if the *image* be the *lower*, the glass stoops *forward;* if it be the *higher*, the glass leans *backward.* The position is rectified by the screws.

(3.) The line of sight of the telescope must be parallel to the plane of the instrument in which the index moves.

Place the two wires of the telescope parallel to the plane of the instrument. Select two distant objects from 100° to 120° apart, as two stars, or the sun and moon, and make an exact contact at the lower wire, or that nearest the instrument. Now move the instrument so as to throw the images in contact upon the upper wire; if the contact is still perfect (the images having overlapped in the middle of the field), the adjustment is perfect; if they have separated, the object-end of the telescope droops; if they overlap, it rises. The position is rectified by the screws in the collar. When this adjustment is defective, the observed angle is always *too great.* (See Table 54.)

[4.] *Index-Error.*

496. The graduation of the arc should commence at a certain point; when this is not the case, the Index-Error, as it is called, must be measured.

The point at which the graduation of the arc is supposed to begin, is that at which the index stands when the mirrors are parallel, as is the case when the image of a distant object is seen to coincide with the object itself. The index-error, therefore, is merely the error of the place of the *beginning* of the divisions, and affects all angles alike.

To find the Index-Error. (1.) By the Horizon. Hold the instrument vertically, and make the image of the horizon coincide with the horizon itself as accurately as possible. If the 0, or zero of the index, now stand at 0, there is no index-error; if it stand *on* the arc, the index-correction is so much *subtractive*; when *off* the arc, *additive*.*

Ex. The horizon and its image being made to coincide, the reading is 3′ *on* the arc Then 3′ is the INDEX CORRECTION to be *subtracted* from every angle observed.

Any distant object, or a bright star, answers the purpose.

(2.) By the Sun. Measure the sun's horizontal diameter,† moving the index forward on the divisions; read off the measure which will be *on* the arc; then cause the images to change sides by moving the index back; take the measure again, and read off; this reading will be *off* the arc: half the difference of the two readings is the index-correction.

When the diameter *on* the arc is the *greater*, the correction is *subtractive*; when the *lesser*, *additive*.‡

Ex. 1.	On the arc	32′ 10″	Ex. 2.	On the arc	30′ 10″
	Off	29 50		Off	33 40
		2 40			3 30
IND. CORR. *subtract*		1 10	IND. CORR. *add*		1 45

In consequence of the spring or elasticity of the index-bar, the error will be different for the *onward* and for the *backward* motion of the index. It has been recommended, therefore, to turn the tangent-screw right and left alternately, in making successive contacts, by which a partial compensation is obtained. This source of discrepancy is, however, effectually removed by taking all observations, including that for index-error, with the same motion of the index-bar. The *onward* motion being adopted as the most natural, the tangent-screw is always employed to close the object and the reflected image, and is thus always turned in the same direction.§

One-fourth of the sum of the two readings should be equal to the sun's semi-diameter in the Nautical Almanac. This affords a test of the accuracy with which the observation has been made.

497. The adjusting screws are *never to be touched except from*

* When the mirrors are parallel, a very distant object is exactly covered by its image; but at a near object the distance between the mirrors subtends a sensible angle, or has sensible *parallax*, and this coincidence does not take place. The parallax of a 12-inch sextant at half a mile distance is about 21″, and is smaller for smaller dimensions and greater distances, in simple proportion. Hence, for the purposes of adjustment, distances exceeding this should be employed.

Captain Beechey suggests a method of adjustment by parallel rays. Naut. Mag. 1844. p. 505.

† As the refraction increases towards the horizon, the lower limb is more raised than the upper limb, and the vertical diameter is shortened. This, at very low altitudes, produces a flattened or oval form in the sun and moon.

‡ If both readings are on the arc, which can only occur when the index-error is nearly half a degree, the ind. corr. is the mean, and subtractive; if off, additive.

§ Sir F. Beaufort, to whom I am indebted for the suggestion, acquaints me, that from the sensible influence of the spring of the index-bar in nice observation he uniformly adhered to this plan, and caused it to be followed by his officers.

The late Captain Basil Hall informed me that he made it his practice to obtain the index-error both for the onward and the backward motion of the index employing the former error in all observations by the onward motion, such as the lunar distance when increasing, and the latter in observations by the reverse motion, as for the lunar distance when decreasing.

necessity, and then with the greatest possible caution.* When two screws work against each other, care must be taken, in tightening one, to loosen the other if necessary.

498 Besides errors from these causes, there are others which are neither detected nor remedied so easily: the divisions on the arc are liable (though in these days in a very slight degree) to inaccuracy, and the centering of the arc is not always perfect.†

In order to test the accuracy of the arc in either of these respects, in different places, it has been proposed to measure the distance of two stars, comparing the distance with that shewn by a circle, or by an approved sextant, or deduced from calculation.‡ The absolute error being thus found for certain places on the arc, the correction for any angle may be inferred by proportion.

499. As the two sides of the coloured glasses are not always exactly parallel, the shades may vitiate the angle. (No. 491.) Some observers find, by actual trial, the error due to any shade or combination of shades. The shade in the eye-piece, as before stated, has not this defect; § but an image-shade is generally indispensable in taking a lunar observation.

[5] *Methods of Increasing the Efficiency of the Sextant.*

500. The necessity, under certain circumstances, of observing large angles, and the difficulty of measuring them, arising from the obliquity with which the rays of light, in such cases, fall on the central mirror, have led to the suggestion of various plans for extending the powers of the sextant.

Capt. Fitzroy has employed an additional fixed horizon-glass, placed at a constant angle with the ordinary one, by means of which the image of an object above, or to the right-hand of another in the

* Particular attention is called to this point, because it is a common failing of "over-handy gentlemen" (to use Troughton's language) to "torment" their instruments. It is better that error should exist, provided that it is allowed for nearly, than that mischief should ensue to the instrument from ignorant attempts at a perfect adjustment; and the skilful observer, instead of implicitly depending upon the supposed perfection of his instrument, will endeavour to avail himself of those cases in which errors, if they exist, will destroy each other.

† It is also necessary that the two surfaces of the central mirror should be exactly parallel. This parallelism can be tested only by observing an angle between two objects 120° or 130° apart, and then repeating the observation with the mirror in a reversed position. Half the difference, if there is any, between the two results is the angle between the surfaces. As in the best instruments the mirror is fixed, this cannot be put in practice, and the consideration is therefore omitted from the adjustments in the text. This error, however, when it exists, is obviated by the method described in the next sentence of the text.

‡ The stars for this purpose must be taken from the Nautical Almanac, as the places are required with precision. The true distance may then be computed by the rule No. 339 (2), using the Diff. of the stars' right ascensions for D. Long., and their polar distances for the colatitudes. The true distance may then be reduced to the apparent (which is that measured by the instrument), by No. 842, substituting one of the stars for the moon, omitting the second corr., and applying the other star's correction the *opposite way* to that laid down in the tabulated directions for the star.

§ Working with the artificial horizon, the eye-piece of the inverting tube should, if possible, be used instead of the shades of the sextant; if shades are used, endeavour always to use the same. The meridian altitude of the sun should, if possible, be observed with the eye-piece, as the latitude obtained from it can then be meaned more satisfactorily with that determined by the stars.

line of sight, is seen in the field when the index is at 0, and thus a portion of the angle is measured in addition to that on the arc.

501. Admiral Beechey had a sextant constructed with a second central mirror over the usual one, and working on the same pivot, the arc of which, being concentric with the usual arc, is divided by the same stroke. Both index-glasses are adapted to the same horizon-glass.*

Any angle is measured by putting one index forward upon the arc to any convenient number of degrees, and moving the other until both reflected images are seen in the horizon-glass.

Each arc has its proper index-error.

502. Mr. C. George, R.N., has constructed a double pocket-sextant, by joining two small sextants by the face. This instrument, which scarcely exceeds the box-sextant in size, possesses for various approximate purposes, and for surveying, the advantages of the double sextant.†

503. The double sextant has some important advantages; it affords two alts. of the same or different celestial bodies in quick succession: this is a point of much consequence when the body appears for short intervals only, as between flying clouds, and also in observing at night, as it saves the disturbance to the eye caused by reading off; it measures the angular distance between opposite points of the horizon,‡ and thus serves as a dip sector; it measures two terrestrial angles at the same instant, and thus serves as a director.

The index-error of a compound angle measured by a double sextant is composed of the errors proper to each arc.

The error of parallelism (No. 495) in a compound angle is materially reduced, since in practice each portion is less than 90°.

504. In observing altitudes at sea by the double sextant, set any angle on the upper sextant; then, facing that part of the horizon which is opposite the sun, find his image, and bring up the horizon to the lower limb, by moving the lower index: the sum of the two readings is the suppl. of the alt. of the upper limb, affected by the dip and the index-error.

Now unclamp the indexes, set the upper one to an angle less than the alt., find the image under the sun, and bring up the horizon to the lower limb: the sum of the readings is the alt. of the lower limb, affected by the dip and the index-error.

Half the difference of the two sums is the app. zen. dist. cleared of the dip, semi-diameter, and index-error.

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* Admiral Beechey acquainted me that he constructed this sextant for the purpose of obtaining the measures of the angles between two terrestrial objects at the same instant and by one observer: a point of considerable importance in surveying, or in laying down soundings, while the observer himself is in motion. A further advantage afforded by the construction is, that when the right-hand object is too faint to be reflected, the sextant does not require to be inverted. The instrument is constructed by Cary.

† Made by Cary.

‡ The difference between this angle and 180° is twice the apparent dip. Thus, if this angle, measured downwards, is 179° 48′ 30″, the apparent or actual dip is 5′ 45″. The dip sector, being inconvenient and little used, is not described in the text.

2. *The Repeating Reflecting Circle.*

505. On this circle the measure of the angle observed by reflection, as in a sextant, is carried over any part or the whole of the circumference: this is effected by making the horizon-glass itself movable round the centre, and attaching to it a vernier. By thus *repeating* the same angle on different parts of the divided edge, the errors of the index, of the coloured shades, and of the centering, are nearly, if not altogether, removed; also, since the indexes follow each other round the circle (each mirror alternately acting the part of the fixed horizon-glass), the angle finally registered is the sum total of all the repetitions; and thus one reading alone contains the result of any number, however great, of separate observations. The arc read off, divided by the number of observations, gives the measure of the required angle.

506. When the angle changes during the observation, the arc finally registered is not the mere repetition of the same angle, but the sum total of *different angles;* it is therefore necessary to understand how the *time* is to be noted.

Suppose, for example, at $5^h\,20^m$ the angle is $45°$, and at $5^h\,26^m$ it is $46°$ (neither being read off); now, at $5^h\,20^m$ the first index would shew $45°$, and at $5^h\,26^m$ the second index would shew the sum of $45°$ and $46°$, or $91°$, *half* of which, or $45°\,30'$, in this case obviously corresponds to the *middle* time, $5^h\,23^m$.

The same appears generally thus: the last arc read off measures the first angle, the repetition of the same angle, and the change upon it during the interval of the two observations; therefore half the arc measures the angle, and half the change upon it, supposed uniform, which corresponds to the middle time.

If, now, a second pair of angles, as before, be observed, a second angle with its time is obtained, and so on; hence, as long as the change of the angle is *uniform*, the arc read off, being divided by the number of observations, corresponds accurately to the mean of the times.

The time is therefore to be noted at each contact.

507. The Circle is made in various forms: we shall confine ourselves here to the description and use of those known by the names of Borda's and Dollond's Circles.* Figures are purposely omitted, and the general description will be easily followed with the instrument itself.

In using the circle, care must be taken to push the crooked handle out of the way of the telescope.

* Troughton's Reflecting Circle, which does not repeat, is capable of great precision; but it does not seem so well adapted to general practice, especially at sea, as the repeating circle: for the three indexes aggravate the inconvenience and tediousness of reading off; and the instrument, instead of facilitating, like the repeating circle, the multiplication of observations, affords merely a correct measure of an angle which, from the motion of the ship, is itself observed inaccurately.

[1.] *Borda's Circle.*

508. In Borda's Circle, the horizon-glass and telescope revolve together round the centre, like the central mirror, carrying a vernier, which we shall call A.

Sometimes another vernier is placed opposite to A, and moves with it. The central mirror carries, like a sextant, a vernier, which we shall call B. The circle is divided into 720°.

The horizon-glass and telescope are attached to an inner circular arc divided to degrees, which is called the *finder*, as it enables the mirrors to be set to contain any angle, and the objects can thus be at once brought into contact roughly. When B is set to 0 at the middle of the finder, the mirrors are parallel. The divisions on the finder are reckoned in both directions from the 0.

509. To use the circle as a sextant. Before this can be done we must know the reading of B when the mirrors are parallel. To find this, set A accurately to 720°,* and clamp it. Set B to 0 on the finder, nearly, and measure the sun's horizontal diameter: read off. Cross the reflected image to the other side of the sun, and read off: the mean of the two readings is the *constant angle* required, and is clear of index-error.

To observe, move B as in a sextant.

After observation, examine the setting of A, as any error in this is so much index-error.

510. By moving the index opposite ways, observations may be taken backwards and forwards, from the same point on the arc; but the real efficiency of the repeating circle consists in what is called the *cross-observation*, to which we shall now proceed.

To observe an Altitude by the cross-observation. Set A† accurately at 720° (or at 360°); set B to 0 on the finder roughly; observe the alt. with B as with a sextant; read off B roughly on the finder; unclamp A, and move it on the finder, in the order of the divisions on the circle, till the 0 on the other side of B stands at the angle read off. Turn the circle over, hold it in the other hand, and complete the contact by turning the tangent-screw of A.

The vernier A now registers the *first pair*, or *double* the altitude required.

To proceed with the repetition. Unclamp B, set it on the finder at the same angle as before; hold the instrument as for the first observation; complete the contact. Unclamp A, move it onwards as before till the 0 stands at the angle read off; complete the contact. This is the *second pair*, or *four times* the required altitude.

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* This index will, in some circles, stand at 360°, and may require to be moved backwards; 360° would then be subtracted from every angle measured by this index alone. The above instructions will, with a trial or two, be found sufficiently intelligible.

† It is usual to fix first the index called here B, as directed by Borda himself, and repeated by other writers; but it is immaterial which index is first fixed, or at what part of the circle, provided the vernier be read off. The index A is recommended here in order to assimilate as much as possible the use of the circle to that of the instruments with which we are already more familiar. Inaccuracy in this setting is diminished as the number of repetitions is increased.

The next reading of A will be six times the required altitude, and so on.

511. To observe Angular Distance by the cross-observation. Proceed as directed above, reading distance for altitude.

512. If there is not light enough to read the finder, the reflected image must be actually carried across the other object by moving the index through twice the angle first measured.

513. The last pair completed being registered by the vernier A, the disturbing of B at any time is immaterial, since it does not affect the reading of A; but if A is moved, and the observation is interrupted before the new pair is completed, the whole is lost.

514. Two altitudes, of the same or different bodies, may be obtained by reading both verniers;* thus, set A to 720°, observe one alt. with B, as in No. 509. Unclamp A, move it to 0 on the finder, hold the circle in the other hand, and observe the other altitude.

Read off B, and subtract from it the constant angle: the remainder is the first alt. For the second alt. subtract the first alt. from A.

Ex. B 252° 2'; A 98° 11'; const. 213° 35'. The First Alt. is 38° 27'; the Second is 59° 44'.

515. We shall now consider the effects of errors. The index-error is obviously removed by measuring the same angle, either on opposite sides of a fixed zero, or between any two points on the arc. Now, after B has been clamped, and the angle is to be repeated by moving A, the horizon-glass passes from one side of the perpendicular upon the central mirror through the same angle on the other side; the angle, therefore, is measured by the motion of A from one point of the arc to another, and the exact point 720° is assumed merely for convenience in reading.

When a coloured shade is defective, it breaks the direct course of the ray from the central mirror to the horizon-glass, and the broken part inclines towards the same side of the horizon-glass, whether the circle is inverted or not. Therefore, if the angle formed on one side of the perpendicular on the fixed mirror is too great, the angle formed on the other side will be too small, by the same quantity, and this error disappears.

The inclination of the line of sight upon the plane of the circle, No. 495 (3), produces the same effect upon the angle formed upon either side of the perpendicular to the central mirror; this error therefore remains.

The error of the eye, and therefore the personal equation (No. 175), likewise remains.

The error of centering is removed by carrying the angle round the whole circumference.

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* This may be found convenient in taking a lunar at night, since the lamp would be required but three times for reading, in obtaining the four altitudes required and the several pairs of distances. Rules might easily be given for repeating both altitudes to any extent, but an allowance would be necessary for the motion in altitude of the second body observed.

[2.] *Dollond's Circle.*

516. Dollond's Circle consists of two concentric circles, the inner one of which, in revolving within the other, carries the horizon-glass and telescope, and a vernier called A, of which the clamp and tangent screw are attached near the telescope. The inner circle is cut to degrees only; the central mirror carries a vernier called B, as in a sextant.

The inner circle answers the purpose of the finder above described. From the position of the telescope, this circle is held, in taking altitudes, exactly like a sextant, which is a convenience. From the general resemblance between the two instruments, it is unnecessary to enter into further details.*

II. The Artificial Horizon.

517. The Artificial Horizon is a small shallow trough, a few inches in length, containing quicksilver or any other fluid, the surface of which affords a reflected image of a celestial body. The fluid is protected from the disturbing effects of the air by a roof, of which the two opposite sides contain plate-glass. This roof is often made to fold up for the sake of portability. The trough should be so thick as to raise the quicksilver to a level with the lower edges of the glasses.

A piece of talc, which substance splits into thin parallel plates, may be laid on the trough as a substitute for the roof. In some cases a piece of thin cloth, as muslin, sufficiently transparent to allow a bright object to be seen through it, protects the fluid from the wind.

518. The image of a celestial object reflected from the surface of a fluid at rest appears as much below the true horizontal line as the object itself appears above it; the angular distance measured between the object and its image is therefore double the altitude. An advantage resulting from this is that in halving the angle shewn by the instrument we halve, at the same time, all the errors of observation. The reflected image in the fluid is always less bright than the object, but as it is perfectly formed, and as the surface is truly horizontal, the artificial horizon, when it can be employed, is always to be preferred to the sea-horizon.

* It is the opinion of some competent judges that circles should be made much smaller, for the sake of lightness and portability, and that they should accordingly be cut to minutes only, as Borda's Circle formerly was; because, by repetition, the minute or nearest half-minute read off is speedily reduced to quantities smaller than can be measured in the observation.

The case of a sextant, or circle, should be made to receive the instrument permanently with the index in any position, as the reading off, which is always difficult in defective light, might thus be deferred to a more favourable opportunity. It would also be useful for reference in cases of error or doubt in the reading, especially at night, to leave the index undisturbed till the result had been worked out.

When the altitude exceeds 60°, the altitude by reflection exceeding 120° falls without the limits of the sextant. In low latitudes, therefore, it is often impossible to observe with the quicksilver except by a sextant with additional powers.* On the other hand, when the altitude is low, the observer is obliged to increase his distance from the quicksilver, by which it becomes difficult to keep sight of the image reflected in the fluid; and for altitudes less than 12° or 15° the observation is generally impracticable.

519. The roof should generally be placed upon a sheet of some thin material, impervious to vapour, which, condensing on the glass, obscures the image. A leaden stand about the size of an octavo volume, on three legs, and covered with cloth, into which the roof sinks and excludes the external air, is convenient.

520. The film, or scum, which forms on the quicksilver, is prevented from running into the trough by holding the bottle inverted while it is poured out. A wooden scraper, fitting close to the inner breadth of the trough, has been found to remove the scum, which adheres to the wood.

521. The fluid proper for the purposes must possess the qualities of giving a bright image, and of quickly subsiding to a perfect level after being disturbed, such as quicksilver, water, spirit, and others.

An ingenious, handy, and portable mercurial horizon by the late Captain George, R.N., made by Cary, 181 Strand, is recommended. It consists of a disc of glass floating on mercury, in a vessel which it nearly fits, and it has an arrangement by which the mercury is introduced, ready filtered from an attached reservoir, and afterwards withdrawn, in a manner which saves a great deal of trouble. The glass floats without touching the sides of the trough, and the whole of the mercury below is serviceable. Another advantage is, that the edges of the trough cut off proportionally less of the field of view, hence very low altitudes may be observed with this instrument. The glass must necessarily be of the best workmanship.

When the air is calm, a piece of water, or a puddle large enough merely to exhibit the image, is often a complete substitute for the quicksilver.†

522. As the celestial bodies are sometimes distinctly visible when the sea-horizon is enveloped in mist,‡ attempts have been made to

* To remedy this defect, it has been proposed to use a reflecting surface, inclined at a constant angle to the horizon, movable on a level surface or floating in quicksilver. Also, a sextant has been fixed, with its plane vertical, to a pillar turning on an upright axis, and the telescope laid nearly horizontal by a spirit-level, the image of the body being brought down to a horizontal wire in the telescope.

† A small piece of plate-glass levelled by a bubble is sometimes used, but the performance of this instrument is not always satisfactory.

‡ Capt. Scoresby ("Journal of a Voyage to the Northern Whale Fishery," p. 159), remarks, that fogs often cover the sea in the polar regions to the depth only of 150 or 200 feet, while the sky is perfectly clear.

Her Majesty's sloop Zebra was a week without interruption in a dense fog, to the southward of the Snares, during the whole of which time no observation could be taken, though the sun often shone brightly (Naut. Mag. 1844). The like circumstances occur in "the Smokes," on the coast of Africa.

obtain an artificial horizon adapted to be used on board ship, by means of the surface of a viscid fluid, and a mirror attached to a pendulum, which, by its weight, hangs vertically.*

The objections to the first of these have already been stated. With regard to the motion of a pendulum, it is important to observe that when the ship comes to the end of her roll or lurch, it does not at once rest in the vertical position, but continues to move onwards or to swing, with the velocity which it had before the ship's motion was destroyed; hence the pendulum moves through greater angles than the ship. By combining, however, the viscid fluid and the pendulum, Commander Becher has obtained a method of measuring altitudes at sea, independently of the horizon, which appears, from the reports made upon it, to afford sufficient accuracy for common purposes, when the motion of the ship is not very great.† Outside the horizon-glass of the sextant is a small pendulum, an inch and a half long, suspended in oil; to this is attached a horizontal arm, carrying at the inner end a slip of metal, the upper edge of which, when seen in a certain position, is the true horizon.

The error is determined by observation of a known altitude, or by the help of another sextant, and is the same for all altitudes. It should be frequently examined.

A lamp is attached for observing at night.

523. Admiral Beechey fitted, within the telescope of the sextant, a balance carrying a glass vane, one half of which is coloured blue, to represent the sea-horizon, and to which the celestial object is brought down. The amount of oscillation above and below the level is indicated by divisions on the glass, the values of which are determined by the maker.

The instructions for using this instrument are as follows:—Bring down the object, as the sun's limb, to the edge of the blue and leave it there. As the ship rolls, catch with the eye the upper and lower divisions reached by the object, and call them out to an assistant, who writes them down with the time against each. When two or more such readings have been taken, read off the alt. and write it down. Take the mean of the readings of the vane and turn it into arc according to the scale furnished. When the mean is *above* the edge, *add* it, when *below*, subtract it. Apply the maker's index-error; the result is the apparent alt. being clear of dip.

Ex. Took an alt., and readings as follows; the divisions 12′ each:—

	h	m	s	Divis.				°	′	″
	10	50	0	(+1) above	the blue edge		Observ. Alt.	20	25	20
		50	30	$(-1\frac{1}{2})$ below			Mean of Div.		− 6	
		50	50	$(+1\frac{1}{2})$ above				20	19	20
		51	20	(−2) below			Maker's Ind. Corr.			− 40
Mean	10	50	40	$(-\frac{1}{2})$, $2\frac{1}{2}$ above, $3\frac{1}{2}$ below; diff. 1 *below*; the half is $\frac{1}{2}$ of 12′ or 6′ to be *sub.*			App. Alt.	20	18	40

* It has also been attempted, but without success, to employ the principle upon which a top while spinning tends to preserve a vertical position, by balancing a horizontal mirror on a pivot, and causing it to revolve with great velocity.

† See Naut. Mag. 1844, p. 291. Several reports, with observations made by this instrument, will be found in the Naut. Mag. of 1839, 1842, 1844, &c.

Care is to be taken to observe as near the centre of the field as possible, and exactly under the sun; the elbow should rest on some firm support.

With practice the instrument affords considerable accuracy; and in smooth water the mean of some alts. will be within 2′.

A lamp illuminates the telescope at night.*

524. An instrument for this purpose, indispensable when the horizon cannot be seen, will also be of great service as a check, when haze or fog, by its partial distribution, produces the appearance of the horizon where it is not.† The same applies to the uncertainty in the place of the sea-horizon which is often experienced in moonlight nights.

These instruments are very convenient on shore.

III. The Chronometer.

525. The chronometer is a superior kind of watch, furnished with an apparatus by which the changes in the rate arising from the expansion or contraction of the materials by heat and cold are nearly obviated.

Chronometers should be kept near the centre of gravity of the ship, which is a little below the water-line, and not far from the middle of the length, not so much because the motion here is less than elsewhere, as because the temperature below is not liable to sudden changes. In ships in which great attention is paid to the chronometers, they are usually kept in a small apartment abaft the mainmast, on a table, in cases lined with cushions of soft wool, which defend them from the jerks and vibrations of the ship. The table is secured to a beam of the deck below, and in small vessels sometimes rests on a stanchion rising from the kelson. Large chronometers are placed in jimbals, in order to preserve a horizontal position, as inclining a watch from this position affects its rate. They have also been hung, perhaps with the view of obtaining both these objects together, in swing trays; but as this method is found to be very unfavourable, it has been discontinued.‡

The chronometer-table has been itself placed in jimbals. It has also been supported by springs to diminish still further the effect of shocks.

526. When a chronometer is placed on board it should always remain in the same position, that is, with the XII towards the same

* Made by Cary.

† Adm. Bayfield acquaints me that he has been completely deceived in the place of the horizon at the coming on of a fog.

‡ Mr. Fisher acquaints me that he has found an acceleration of seven seconds a-day produced by suspending a chronometer in a cot with five inches' swing.

part of the ship, since it has been found that disturbing the positions has altered their rates.*

When a chronometer is transported from one place to another, it should be compared, before and after moving, with another chronometer or a good watch, in order to ascertain whether its regularity has been disturbed.

527. A chronometer should be wound up at regular intervals, in order that the same parts of the machine may undergo the same constant action; it should, therefore, be wound up at the same hour every day. In winding, the key should be turned steadily, and about half a turn taken each time, and the watch should be wound close up. After winding, the chronometer should be examined, to ascertain that it has not stopped.

In winding up a watch, the key alone should be moved, as to turn the watch itself is to increase the velocity of winding.

When a chronometer is wound up after running down, it is set a-going by giving it a small horizontal circular motion.

When a chronometer stops, it generally alters its rate.

528. It seems generally admitted that the principal cause of the variation of the rates of chronometers is change of temperature,† and accordingly, in some ships, the temperature of the chronometer-room has been regulated by lamps.

When the ship changes her climate, the rates do not change at the same time with the temperature, but some time afterwards.‡

529. It has been found that magnetism affects the rates of chronometers (see a paper by Mr. Fisher. Nautical Magazine, 1837). Hence it follows, that the magnetism of an iron vessel may produce similar effects. Their rates will certainly be affected by the proximity of apparatus generating or conveying electric currents.

530. Chronometers are generally found to perform best at the

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* This depends, however, chiefly on the position of the arm of the balance.

† Captain R. Owen, while employed in surveying in the West Indies, found a fall of 14° in Fahrenheit's thermometer (from 82° to 68°) accelerated the rates 1s·5 a-day, and a fall of 20° (from 82° to 62°) accelerated them two seconds a-day.

‡ Admiral Fitzroy, who employed in his surveys of South America the unusual number of twenty-two chronometers, observes, that the ordinary motions to which chronometers are subjected, both from the incessant action of the sea and in transferring them from one vessel to another, scarcely affect the rates of good watches; and that, in general, temperature is the only cause of the alteration of rate. (Journal of the Royal Geographical Society, vol. vi.)

Sir E. Belcher, however, when engaged in the survey of the west coasts of North America, found the chronometers of H.M.S. Sulphur very materially deranged by the jerking produced by a looseness about the rudder-head and from towing the Starling, her tender; and observes, that when these causes were removed the watches performed admirably.

In the Instruction Réglementaire pour les Bâtiments de la Marine Royale, &c. (Annales Maritimes, 1840), it is recommended that the chronometers should be held in the hand during the firing of guns, and that in transporting a watch from one place to another it should be carried in both hands, in order to avoid giving it suddenly a circular motion, which may be communicated by taking it up by a handle, or becket, at the top of the case.

M. Givry considers that the rates of the chronometers of La Coquille frigate, commanded by M. Duperrey on a scientific expedition, were altered by the severe thunder-storms experienced on the coast of Timor, in August 1823.—Mémoire sur l'Emploi des Chronomètres à la Mer, par A. P. Givry, extracted from the Annales Maritimes, Paris, 1840.

It has been surmised that the hot and moist climate of the coast of Africa has speedily disturbed the rates of chronometers; but Adm. Vidal and Sir E. Belcher, in several years' experience, have recognised no such effect.

beginning of a voyage;* many subsequently become useless from irregularity, and some fail altogether. They are liable, also, to change their rates suddenly, and then to reassume the former rates in a few days.†

531. Since there seems no reason why any cause which alters the rate of one chronometer should not alter the rate of another in the same manner, the agreement of any number of chronometers, however great, cannot be unreservedly admitted as evidence for the truth of the time which they shew. Their irregularities, however, in this respect contribute to the security of navigation; for since one chronometer often gains while another, under exactly the same circumstances, loses, the discrepancies prevent the danger of trusting too confidently to any single result.

CHAPTER III.

Taking Observations.

I. Observing Altitudes. II. Observations with and without Assistants. III. Employment of the Hack Watch. IV Finding the Stars.

532. In treating of observations with reflecting instruments we shall refer chiefly to altitudes, as most convenient for the purposes of illustration. If, however, for the *horizon*, we substitute a celestial body or any other point, what is said of altitudes will apply, with certain obvious exceptions, to angular distance generally. The details proper to the particular observations will be found under their respective heads.

I. Observing Altitudes.

533. The observer will do well to accustom himself to obtain a single sight with accuracy, and not to depend upon the accidental compensation of errors due to want of care. It sometimes happens that a single sight only can be obtained, and no good estimate of its

* Advantage was taken of this circumstance in the late survey of part of the west coast of Africa by Admiral Vidal, who, by direction of the Hydrographer, proceeded at once to run down the coast from Sierra Leone to Corisco Bay, and returned to Sierra Leone as quickly as possible. The whole Diff. Long. between these points, as measured in both runs, agreed within 1s.

† Captain R. Owen remarks, that most of his chronometers took thus a jump of one or two seconds in the daily rate, more than once during his surveys in the West Indies. Other officers have made similar remarks.

value can obviously be formed if the observer knows his observations by their general result only.

1. *At Sea.*

[1.] *Above the Sea Horizon.*

534. The instrument must be vibrated or swung, so that the image may skim the horizon, for the altitude must be measured to the point vertically under the body,* No. 487.

535. When the altitude is above 60°, it may be observed both from the opposite point of the horizon and from that under it, by the common sextant. Half the difference of the two readings is the apparent zen. dist., No. 432. By this means the dip, with the uncertainty to which it is liable, and the index error, are removed. As the apparent dip is always uncertain, and as the rules given in No. 208, though generally true, do not always hold good for small differences of temperature, it will be advisable, whenever precision is required, to attend to this consideration.

536. It is, in general, taken for granted that the dip is in the same state all round the horizon.

This supposition M. Arago, in discussing the observations made by Sir E. Parry in his first polar voyage, by Capt. B. Hall in the China Sea, and by M. Gauttier in the Mediterranean and Black Seas, thinks there is no reason to doubt. ("Conn. des Tems," 1827.)

Capt. Fitzroy found however a difference of 16′ on one occasion; and Capt. Bayfield informs me that he has often observed the dip not to be the same all round the horizon, more particularly on the coast of Labrador and in the Straits of Belleisle, where currents of unequal temperature prevail. See also note *, p. 196.

When circumstances allow, alts. should accordingly be observed at opposite points of the horizon. The mean of two alts. in such cases may not, indeed, be exactly true, but it is probably nearer the truth than one of them alone might be. For the same reason it is advisable to select stars on opposite bearings.

When both the alt. and its supplement are thus measured, and the alt. is in a state of change (as will always be the case except when the object is on the meridian), the time must be noted at each of the two contacts; and the half difference of the alt. and its suppl is the apparent zenith distance of the centre corresponding to the mean of the times.

When the altitude is below 60° a sextant of additional powers, or a circle, is in general necessary for this observation. (See No. 504.)

537. When the altitude of a body is near 90°, it is proper, before attempting to bring down the reflected image, to ascertain, by re-

* When the 4th Adjustment, No. 195 (3), is not perfect, we look at a point of the horizon not directly under the sun. Hence a tube should be used to insure the eye and the contact of the images being at equal distances from the plane of the instrument. On the same ground, Dr. Maskelyne recommends the observer, when without a tube, to turn on his heel while causing the image to skim the horizon. (Nautical Almanac, 1774.)

ference to the zenith, or the compass, the precise point over which the body is vertical.

538. When fog obscures the sea-horizon from the deck, a new horizon may often be obtained by descending the ship's side, or from a boat. See No. 550, note.

539. When the limbs of the sun or moon are indistinct, altitudes of the centre are obtained by bisecting the hazy or cloudy disc upon the horizon.*

540. In observing the moon's altitude there is a choice of the upper or lower limb when she is at the full, and also when the line of cusps, or horns, is vertical. At other times her illuminated limb, whether it be the upper or lower one, must be brought down to the horizon.

Mistakes may arise in observing the moon's altitude at sea by night. When the sky under the moon is unclouded, the upper edge of the illuminated part of the sea is the horizon; but at other times long dark shadows are projected on the water, which render it difficult, and sometimes impossible, to discern the horizon.

When the moon's alt. and its supplement are both measured, if she is full, or if the line of cusps is vertical, her alt. may be observed as directed in No. 535. But in other cases the same limb must be referred to the point of the horizon under her and to that opposite; half the difference is then the app. zen. dist. of the limb observed, and the semidiameter must be applied accordingly.

When the horizon under the moon is unfavourable for observation, and the supplement of the alt. alone is employed, correct the angle observed for index-error and dip, take the suppl. of the result to 180°, and apply the semidiameter as to the alt. taken directly.

541. The obscurity of the sea-horizon in a dark night renders it difficult to observe the altitudes of stars or planets; but in the twilight, when the sky is clear, the boundary of the sea exhibits a strong dark edge, most favourable for observation.

The difficulty of reading off at night is easily overcome by having a well-trimmed dark lanthorn, and a handy assistant.†

When the alt. of a star or a planet is measured both from the horizon under it and opposite to it, half the diff. of the two angles is the app. zen. dist. If the supplementary arc alone is employed, correct it for index-error and dip; the supplement of the result is the apparent altitude.

542. When a telescope is used the unemployed eye must be closed, but when the plain tube is used it should, when convenient, be kept open, because the image being seen by both eyes under the same magnitude, one assists the other.

This should be practised in observing stars at night.

La Caille recommends keeping the eye some minutes in complete

* Mr. Fisher tells me that he has repeatedly employed, with complete success, altitudes of the sun faintly seen through watery clouds, when those who had been used to depend solely upon the perfectly defined disc had despaired of an observation altogether. In such cases the altitudes have not greatly differed from each other, and the mean of several has been quite equal to an ordinary observation of the limb

† A small electric light (half candle power) is found useful.

darkness before observing stars at night. (Guépratte, "Problêmes d'Astron. Naut." &c., tom. i. p. 20, 1839.)

543. Different powers suit different eyes. Too low a power does not magnify enough; too high a one makes it difficult to keep the object in the field on the least motion of the instrument. The observer, therefore, will employ those powers only in which the advantage gained by a larger image exceeds the disadvantage of increased unsteadiness.

A plain tube, however, should be used in all other cases, both for directing the sight to the proper point of observation, and for defence against disturbing lights.

544. All observed angles are vitiated by the errors of the instrument enumerated in the last Chapter, Nos. 495, 498, and 499. Again, each observer has in general some peculiarity in the manner of observing, or in the quality of the eye itself, which gives rise to a *personal* error, the correction for which is called the *personal equation.* No. 175.

545. Besides these errors, altitudes taken at sea are subject also to others which change with circumstances.

1st. The running of the waves causes the horizon to be in continual motion; 2d. The rise and fall of the observer, both from the lifting of the vessel by the waves, and by her rolling, cause the dip to be in continual change.

The effects of these alternating motions will, in taking two or three altitudes, in part disappear.

3d. The place of the visible horizon changes with the temperature of the sea and the air. See No. 208.* Also, since the sea-horizon is formed by the eminences of the waves, it should be higher in bad weather.†

Besides these distinct causes of error, the motion of the ship disturbs the attention and efforts of the observer.

546. The height of the eye should be ascertained with some precision, that is, within two or three feet, because an error in the dip causes an error of the same amount in the altitude. This is of most importance when the observer is very near the water, as the dip then changes most rapidly; thus, it appears in Table 30, that a change of three feet in the height produces, near the beginning of the table, a change of more than 1′ in the dip, but near the end only

* M. Givry observes ("Mémoire sur l'Emploi des Chronomètres," p. 23), that when the sea is shoal near the horizon, the relation of the temperatures of the sea and the air being different from that at places where the water is deeper, may produce extraordinary refraction: and he attributes to this cause errors amounting to 8ˢ in the time deduced from some altitudes taken near the mouth of the Jeba, in 1818, although circumstances appeared at the time in every respect favourable for observation.

M. Givry remarks, further, that extraordinary refraction sometimes takes place in the neighbourhood of sandy plains, the heated air of which, passing over the sea, produces partial inequalities of temperature; and he adds, that small undulations in the horizon are always indicative of irregular refraction.

† It is stated, "Voyage autour du Monde," 1840, by M. Du Petit Thouars, in the Venus French frigate, that the observations shewed this. It is probable, however, that the errors of observation due to the motion would, in general, far exceed that due to the above cause.

4′. An altitude observed at the top of a heavy sea will differ considerably from another taken at or below the mean level.*

If the altitude be observed above the deck, as in the top for instance, the horizon will appear better defined, and the variations of the dip by the ship's motion will be less sensible; also the difference of temperature of the sea and the air appears to affect the place of the visible horizon less as the observer is more elevated. Hence it would appear that altitudes should be taken from aloft when convenient.

547. Some observations on the heights, distances, and velocities of waves have been put on record of late years. Sir G. Grey,† in his voyage home from Australia in 1837–8, obtained numerous measures of the distance and velocity of waves, amongst which are the following:—

Dist. 121 ft.	Vel. 14½ Naut. miles.	Dist. 211 ft.	Vel. 19·5 miles.
178	18·7	234	20·5
201	22·5	326	22
205	20·6	338	28

Lieut. Wilkes ("U.S. Exploring Expedition") found the highest waves in a heavy sea off Madeira from 14 to 25 feet high, and their velocity 23 miles an hour; and at another time and place, with a remarkably high and regular sea, 32 feet, with a velocity of 26 miles.

The highest waves observed by Sir Jas. C. Ross, in the North Atlantic, were 36 feet high. The highest sea seen by M. Lazarev, in the Russian Expedition of Admiral Bellingshausen, 1819, was in 56° S. and 103° E., but he does not state the height.

In the Naut. Mag. 1848, p. 228, are the following observations taken near the Cape of Good Hope:—

Height 17 f.	Dist. 35 fath.	Vel. 22 miles.
20	43 to 50	24
22	55 to 57	26 to 27

548. When the spectator nears or recedes from the celestial body, by the progress of the ship, the effect produced on the altitude is the same as that of a motion in the body itself, since exactly the same appearances result from the motion of either while the other remains fixed. Accordingly, in all observations, in which, from the sensible change of altitude, the time requires to be noted at each sight, the progress of the ship is included in the observed change of altitude; and the *place* to which the observation corresponds is that at which the ship was at the mean of the times.

* The height of waves is ascertained by placing one's self at such a height on the vessel, or her rigging, that the tops of the highest waves which pass near the ship may be seen on with the distant well-defined horizon, at the instant when the ship is at the bottom of the hollow between two heavy seas. The height of a wave thus observed, that is, the difference of level between the summit and the bottom of the hollow (which difference is *twice* the height of the summit above the *mean level*), is very nearly the height of the eye above the bottom of the same hollow, the ship at the instant of observation being upright. The distance is measured, when before the wind, by a line with marks on it.

† Governor of New Zealand. I am indebted to the author for these observations, of which I find a few only reduced for the course and rate of sailing of the ship.

[2.] *Altitudes above the Shore Horizon.*

549. It often happens that the horizon is concealed by the intervention of land, while the level surface of the water marks on the shore a distinct horizontal line, which is a substitute for the sea-horizon, and is called a *shore-horizon.*

When the distance of the shore-horizon is known, enter Table 35 with this distance and the height of the eye, and use the correction therein instead of the dip in Table 30.

Ex. From the height 20 feet, observed a merid. alt. 28° 18′, above a shore-horizon, 2 miles and a quarter distant.	Alt.	28 18′
	Corr.	− 7
	Alt. corrected for dip	28 11

550. When the distance of the shore-horizon, or water-line, is not correctly known, it may be found by means of two altitudes, the one being observed from the deck, and the other as high as possible, at the same time.

Divide the difference of the heights in feet by the number of minutes in the diff. of alts.; the quotient is the number of feet subtending an angle of 1′ at that distance. Look in Table 9 for this number of feet, and the corresponding distance is the distance required.

Ex. An observer, at the height of 91 feet above the sea, observed the sun's alt. 41° 37′ above the water-line of the sea; another observer, at the height of 22 feet, observed it 41° 25′: find the distance of the water-line, and correct the alt. for dip.

The diff. of the heights, 69 feet, divided by 12 (the minutes in the diff. of alts.), gives 5·7 feet, which answers, in Table 9, to 3 miles, the Dist. required. Then the cor. in Table 35 to 3 miles, and height 22 feet, is 5′, which subtracted from the alt. taken at 22 feet, gives 41° 20′, the Alt. corrected for Dip.

But as this result, like the preceding, becomes uncertain when the distance is very small, it is always advisable in such cases to endeavour to find, by descending, a natural horizon.*

2. *Observing Altitudes on Shore.*

551. Altitudes are well observed above the sea-horizon from a hill or cliff of known height. Nos. 544, &c. apply, with certain obvious exceptions, to altitudes of this kind taken on shore.

552. In taking the altitude of the *lower* limb in the quicksilver, the *lower* limb of the object is made to touch the *upper* limb of the image in the quicksilver, as reflection inverts the object. In taking the altitude of the *upper* limb, the image of the body is in like manner brought below the quicksilver image altogether. Hence, when the sun is *rising*, and the *lower* limb is observed, the images are continually *separating;* but when the upper limb is observed, they are continually *overlapping;* and the contrary when the sun is falling.

It is useful to attend to this, as it is sometimes doubtful, especially with the inverting telescope, which limb was observed.

* This is the practice recommended, on his own experience, by Dr. Scoresby, "Voyage to the Northern Whale Fishery, 1822, London," p. 441.

553 It is advisable, when circumstances permit, to move the index a little too much, whether forwards or backwards, and clamping it, to wait the instant of contact while the instrument is in a state of repose, in preference to making the contact by moving the tangent screw up to the instant of observation, because the material always springs more or less. Again, moving the tangent screw diverts a portion of the attention which should be devoted to the contact alone. At sea this is rarely practicable in any observation on account of the motion of the ship.

554. The roof of the quicksilver should be reversed at each set of three or five altitudes, in order to remove the effects of errors in the glasses; one face is accordingly marked A and the other B, and these letters marked against the altitudes.

The roof should obviously be used only when it cannot be dispensed with.

555. A stand for the sextant or circle, on shore, is a great convenience, and allows a higher power to be used; practice is, however, necessary, in order to derive the full advantage from it.

556. The accuracy with which a set of altitudes has been observed may, in part, be inferred from their agreement with each other. For since the change of altitude in small intervals of time is nearly proportional to the intervals (unless the object is near the meridian), any considerable irregularity must be a consequence of an error of observation.

The comparison of the differences of altitude, with their respective intervals, may easily be made by means of the Traverse Table, as in the following example:—

Ex. Observed altitudes of Arcturus in the artificial horizon.

	Time	Diff.		Alt.	Diff.
Time	$10^h\ 5^m\ 43^s$	$2^m\ 34^s$	Alt.	$78°\ 59'\ 20''$	45′
	10 8 17	3 12		78 14 30	57
	10 11 29	2 51		77 17 30	44
	10 14 20			76 33 40	

In Table 2, $2^m\ 34^s$, or 154^s, as D. Lat., corresponds to 44 as Dep. at 16°. On the same page $3^m\ 12^s$, or 192^s, as D. Lat., corresponds to 55 as Dep., which is near enough $2^m\ 51^s$, or 171^s, as D. Lat., corresponds to Dep. 49, the Diff. 44′ is therefore in error, and the 3d alt. about 5′ too great.

557. Several altitudes are taken in immediate succession, on the supposition that they are liable to errors of opposite kinds; for, in this case, if one altitude be observed a little too great, and another a little too small, the mean of the two will be nearer the truth than either of them separately; and thus, by increasing their number, the effects of irregularities of observation will be much diminished in the general result.

558. But if the portion of time during which the altitudes are taken be too long, an error of a new kind will arise from the unequal variation of the altitude itself, which never, strictly speaking, varies at the *same rate* at the beginning, middle, and end of an interval.

If a series of alts., at observed equal intervals of time, be cleared of errors, and the differences between them be taken in succession, these differences will generally afford, in like manner, differences among themselves, which are called *second differences;* and if the observations be prolonged, third differences will appear, and so on. When the 2d diff. is insensible, $\frac{1}{2}$ the sum of 2 alts., or $\frac{1}{3}$ the sum of 3 alts., or $\frac{1}{5}$ the sum of 5 alts., corresponds exactly to the middle of the time occupied in the observation; but when the 2d diff. is considerable, the arithmetical mean is in error by a quantity which is as follows:—

The half sum of two alts. at the beginning and end of the interval differ from the alt. proper to the middle instant of the interval by $\frac{1}{8}$ of the 2d diff. proper to the whole interval. The third of the sum of the three alts. at the beginning, middle, and end of the interval, differs from the same alt. by $\frac{1}{12}$ of the whole 2d diff.; and the fifth of the sum of 5 alts. at four equal intervals, by $\frac{1}{16}$ of the 2d diff.

Ex. Lat. 51° 30′ N. Decl. 22° 20′ N.

	Hour-Angles.	Alts.	Diff.	2d Diff.
1st.	$0^h\ 16^m\ 0^s$	60° 40′ 8′	5 33″	
2d.	0 20 0	60 34 35	6 43	1′ 10′
3d.	0 24 0	60 27 52	7 54	1 11
4th.	0 28 0	60 19 58	9 6	1 12
5th.	0 32 0	60 10 52		

The mean 2d Diff. is 1′ 11″ for 4^m; hence, as the 2d Diff varies as the square of the interval (that is, is 4 times greater when the interval is doubled, 9 times greater when it is trebled, and so on), the whole 2d Diff. for 16^m is 4 times 4, or 16 times 1′ 11′, which is 18′ 56″. Then the mean of the 1st and 5th Alts. is 60° 25′ 30″, which differs from the 3d Alt. by 2′ 22″, or 1-8th of 18′ 56″.

The mean of the 1st, 3d, and 5th Alts. is 60° 26′ 18″, which differs from the 3d by 1′ 35″, or 1-12th of 18′ 56″.

The mean of the 5 Alts. is 60° 26′ 41″, which differs from the 3d by 1′ 11″, or 1-16th of 18′ 56″.

The error cannot be materially diminished by further increasing the number of alts.

The correction for this error cannot be given in a concise and convenient form.* But in practice the intervals are not exactly equal; and even if they should be, the errors of observation will often conceal the 2d diff. When, therefore, from circumstances, altitudes can be obtained only at considerable intervals, it is proper to deduce a separate result from each.

The 2d diff. of alt. disappears in two cases: 1st, when the object is E. or W.; 2d, when its motion is vertical.

559. The effect of the elevation of the spectator upon the altitude observed in the quicksilver, is insensible in practice, since, even in the case of the moon, an elevation of a mile does not produce a change of 1″ in her horizontal parallax.

* The change of altitude in a very small portion of time depends on the latitude, and on the azimuth of the object (see No. 669); but the 2d Diff., or *variation* of the change of alt., which becomes conspicuous in a longer interval, depends, further, upon the altitude itself. To exhibit this correction, therefore, a table of *treble entry* would be required.

II. Observations with and without Assistants.

560. When the arc observed is in a state of continual change, the quantity measured corresponds to a particular instant of time. When, therefore, the complete observation consists of various elements whose measures are required at the same instant, either the observer must have assistance, or he must himself obtain the several measures in succession, and these must be reduced afterwards to the same instant by calculation.

When two or more altitudes at sea are required at the same instant, assistants have been employed to observe them. The impropriety of this custom will, however, appear on considering the nature of the errors of altitude (No. 545); for it is obviously impossible for an observer to keep the motion of the index so exactly adjusted to the irregular and often violent motion of the ship, as to be able to seize the altitude at command.

561. The assistant is useful chiefly in noting the time. An observation of a set of altitudes, with their times, for example, is conducted as follows:—

(1.) The observer sets the index to the estimated alt. (No. 492); about ¼ of a minute before he expects to complete the contact, he cries, "Look out!" at the instant of contact, he cries, "Stop!" on which the assistant writes down the second, the minute, and the hour. The observer then reads off the degree, minute, and division of the seconds, as 10″, 20″, 30″, &c., which the assistant writes down. Three, five, or more altitudes make, generally, a set of *sights*.

When the assistants have watches shewing seconds, each takes his altitudes at leisure, and the whole is reduced to the same instant by calculation.

(2.) The times are then added together, and the sum divided by the number of alts. The alts. are then in like manner added together, and the sum divided by their number is, when the second difference is not considerable (No. 558), the alt. corresponding to the mean of the times. When the number of alts. is odd, and the intervals are nearly equal, the means will not differ much from the middle time and its corresponding altitude.

562. When two sets of observations are taken by different persons, nearly at the same time, they are reduced to the same instant thus:—

The difference or change of altitude (or other angular measure) in the time occupied by the observation is given; then the interval between the given mean of the times, and that to which it is proposed to reduce the observation, being found, the quantity to be applied to the altitude is determined by proportion. For accuracy, the change of alt. must be properly computed by No. 669 or 671.

563. The observer should, however, take the whole observation himself, and he will then learn to estimate his results at their real

value, of which he can be no judge when they are taken by other persons.

When the observer takes his own time, he holds his watch in his hand, or places it either where he can obtain sight of it readily, or where he can hear it tick plainly. In the latter case, the first beat after the instant of contact he counts 1, the next 2, &c.; then, looking at the watch, he counts on till the second hand arrives at a marked number of seconds, as 10, 15, &c.; he then writes down these seconds, and after them the number of beats counted, to be *subtracted.*

If the observer can count 10 or 20 seconds without an error of more than 1^s or 2^s, he may put the watch wherever it is most convenient to inspect the face, and thus avoid the principal difficulty in taking the entire observation himself, especially at night.

He then reads off the alt., and sets it down.

The sum of the beats is to be deducted before the mean of the times is taken.

Most watches beat 5 times in 2^s, or each beat counts $0^s \cdot 4$.

Ex. After the instant of contact, 14 beats are counted; the second-hand is then at 30^s, the min. 42, and the hour 10, and so on, as follows:—

	$10^h\ 42^m\ 30^s$	subtract	14 beats.
	10 44 10		32
	10 46 0		11
	132 40		57
	−22·8	(corres. to 57 beats.)	
3)	132 17·2		
Mean	10 44 5·7		

III. Employment of the Hack Watch.

564. This is a portable chronometer, or good watch, used for observation, to save moving the standard chronometer. Since the watch and chronometer will not in general go exactly together, they must be compared both before and after observation, in order to find what time the chronometer shewed when the observation was taken. Thus,

Within 5 or 10 seconds of a whole minute by the watch the observer tells the assistant to "look out" on the chronometer. At the minute he cries "Stop!" when the assistant writes the times, and takes their differences. This should be repeated two or three times, and the mean result employed. The observer can compare alone, by counting the beats of the chronometer till the expiration of the minute.

If the difference between the watch and the chronometer be the same before and after observation, the time of observation by the chronometer is at once deduced from that by the watch; if not, a correction must be applied, as in the following example:—

	Before Obs.		After Obs.		Intervals.
Watch	$3^h\ 21^m\ 0^s$	....	$4^h\ 3^m\ 0^s$	....	$0^h\ 52^m\ 0^s$
Chron.	10 31 18·4	....	11 23 21·7	....	0 52 3·3
Diff.	7 20 18·4		7 20 21·7		3·3

Time of observation by watch, $3^h\ 32^m\ 37^s$: required the time of do. by chron.

The watch here has *lost* $3^s{\cdot}3$ on the chron. in 52^m. The observation taking place $21^m\ 37^s$ by watch, after the first comparison, we have $52^m : 3^s{\cdot}3 :: 21^m\ 37^s : 1^s{\cdot}4$, the *loss* of the watch on the chron. at the time of observ.; this, *added* to $21^m\ 37^s$, gives $21^m\ 38^s{\cdot}4$, which, added to $10^h\ 31^m\ 18^s{\cdot}4$, gives $10^h\ 52^m\ 56^s{\cdot}8$, the TIME BY CHRON. required.

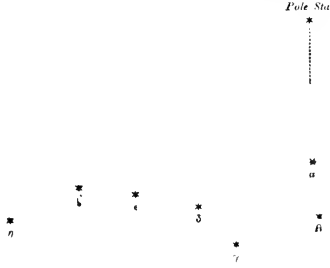
565. When the times by watch are separated by considerable intervals, and the rate of the watch is large, each time may require to be thus corrected for its proper gain or loss.

IV. Finding the Stars.

566. The most conspicuous stars have been designated, from remote antiquity, by names; besides which, the stars in each constellation or group are distinguished, for reference, by letters and numbers. The letters chiefly used for this purpose are the small letters of the Greek alphabet, which, with their names, are written as follows:—

α alpha	ζ zeta	λ lambda	π pi	φ phi
β beta	η eta	μ mu	ρ ro	χ ki
γ gamma	θ theta	ν nu	σ sigma	ψ psi
δ delta	ι iota	ξ ksi	τ tau	ω omega
ε epsilon	κ kappa	ο omicron	υ upsilon	

567. In finding any star in the heavens, it is necessary to refer to some one star or constellation as known: the Great Bear, called also by the Latin name *Ursa Major*, a constellation of the figure shewn below, in the northern part of the heavens, and consisting of seven principal stars, is the most convenient for the purpose.



The two stars *a* and *β* point nearly to the Pole Star (or *Polaris*), and are hence called the Pointers. This star will not easily be mistaken, as it appears always in the same place.

A line from Polaris through *η* (the last of the tail) passes, at 31° beyond *η*, through Arcturus, one of the brightest stars.

A line drawn from *Polaris* perpendicular to the line of the Pointers, and on the opposite side to the Great Bear, passes, at 48° distance, through Capella, one of the brightest stars.

In this same line, about the same distance on the opposite side of the pole, is *a Lyræ*, or the bright star in the Harp, called also *Vega*, and also by seamen Lyra, a large white star.

At one-third of the distance from Arcturus to *a Lyræ* is Alphacca, the brightest of a semicircular group called the Northern Crown (*Corona Borealis*).

A line drawn from *δ* (the faintest of the Great Bear) through *Polaris*, passes through the constellation of *Cassiopeia*.

About 23° to the eastward of *a Lyræ*, and about the same distance as this star from *Polaris*, is the bright star in the Swan (or *a Cygni*). Deneb.

A line from Polaris passing between this last and *a Lyræ*, produced to an equal distance beyond them, passes through Altair (*a Aquilæ*), a bright star between two small ones, the three lying in the direction of *a Lyræ*.

The line of the Pointers, carried through the pole to about 62° beyond it, passes through *β Pegasi*, called also Scheat, and about 13° further, through Markab (*a Pegasi*).

A line from *Polaris*, drawn between Capella and a star near it to the eastward, passes to the westward of the constellation Orion The two northern stars of the four at the corners are the shoulders, the northernmost of which is Betelguese, or *a Orionis*. The brightest of the two southern stars, the feet, is called Rigel. In the middle are three small stars forming the belt, the northernmost of which is nearly on the equator.

About 25° to the northwestward of the belt, and not far out of the direction in which it points, are the *Hyades* and *Pleiades* in *Taurus*; in the former cluster lies the red star Aldebaran.

A line from Aldebaran through the belt passes, at about 20° on the other side, through Sirius, the brightest of the stars.

Sirius, the eastern shoulder, and Procyon (to the northward of Sirius and eastward of Orion), form an equilateral triangle.

Nearly midway between Orion and the Great Bear are the Twins, Castor and Pollux (the southern and brightest), about 4° apart. The line from *Polaris* to *Procyon* passes between them.

A line from *Rigel* through *Procyon* passes, at an equal distance beyond, to the northward of Regulus. *δ* and *γ Urs. Maj.* serve as pointers for *Regulus*.

A line drawn from *Procyon* through *Regulus*, at near'y an equal distance beyond it, passes through *β Leonis*, or Denebola.

A line from δ *Urs. Maj.* through *Regulus*, passes, at 30° beyond, through Cor Hydræ.

A line from *Polaris* through ζ *Urs. Maj.* passes, at 70° distance, through Spica Virginis.

A line from the last star in the tail of the Great Bear through Arcturus will lead to α and β *Libræ*.

Arcturus, *Spica*, and *Denebola* form an equilateral triangle.

A line from *Regulus* through *Spica* passes, at 45° distance, through Antares, a very bright and reddish star.

A line from α *Orionis* (*Betelguese*) through *Aldebaran* passes, at 30° distance, through α Arietis, not a very distinct star.

The Southern Cross is about as far from the South Pole as the Great Bear is from the North Pole; α is the foot, and γ the head.

To the left of the Cross when on the meridian and pointing towards it are α and β *Centauri*, both of the first magnitude.

A line from *Scheat* through *Markab* passes, at 45° from Markab, through Fomalhaut, a very bright star.

Scheat and α Andromedæ, called also *Alpheratz*, form the north side of a square; *Markab* and Algenib on the south side.

Achernar, *Fomalhaut*, and Canopus, are in a line, and nearly equidistant, being about 40° apart.

568. When a few stars are known, the rest are easily found by the times of their Meridian Passages, Table 27, and their Declinations, Table 63, as described in No. 482 (8).

A star may also occasionally be identified by means of its altitude, or azimuth, computed roughly.

CHAPTER IV.

Subordinate Computations.

I. The Greenwich Date. II. Reduction of the Elements in the Nautical Almanac. III. Conversion of Times. IV. Hour-Angles. V. Times of certain Phenomena. VI. Altitudes. VII. Azimuths.

569. Such parts of computations as are common to more operations than one are collected, both to avoid repetition and for facility of reference, in this chapter, which contains also some smaller computations not relating directly to the principal divisions of the subject.*

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* Certain computations in this chapter, though not of immediate application in the present volume, may be found useful for the purposes of verification.

I. The Greenwich Date.*

1. *Conversion of Arc and Time.*

570. To turn Degrees and Minutes into Time.

By Inspection.—(1.) To the whole second. Enter Table 68 or 69 with the given arc, and take out the hour, minute, and second.

Table 68 shews the time to the nearest two seconds.

(2.) To parts of seconds. Take out of Table 17 the hours, minutes, seconds, and parts corresponding to the given degree, min., and sec.

Ex. 1. Turn 36° 11′ into Time.

In Table 68, or 69, 36° 11′ is seen to be $2^h\,24^m\,44^s$ in Time.

Ex. 2. Turn 101° 41′ 45″ into Time.

Ans. by Table 69, $6^h\,46^m\,47^s$ in Time.

Ex. 3. Turn 134° 52′ 9″·7 into Time.

In Table 17, 130°,	8^h	40^m	0^s
4		16	
52′		3	28
9″			0 6
0·7			·05
Time required	8	59	28·65

571. *By Computation.*—Multiply the arc by 4; this turns the degrees into minutes of time, the minutes (′) into seconds of time, and the seconds (″) into thirds of time.†

Ex. 36° 11′ multiplied by 4, is $144^m\,44^s$, or $2^h\,24^m\,44^s$ in Time.

572. To turn Time into Degrees, Minutes, and Seconds of Arc.

By Inspection.—(1.) To the nearest second or two seconds. Employ Table 68 or 69.

(2.) To parts of seconds. Take out of Table 18 the deg., min., and sec. corresponding to the hours, mins., and secs. of time.

573. *By Computation.*—Turn the hours into minutes, and divide by 4; the quotient is the deg., min., and sec.

Ex. 1. $2^h\,24^m\,44^s$ are $144^m\,44^s$, which, divided by 4, gives 36° 11′ in Arc.

Ex. 2. $5^h\,20^m$ are 320^m, which divided by 4 gives 80° in Arc.

2. *Deduction of the Greenwich Date.*

574. The Civil Date begins at midnight, No. 480; the Astronomical Date begins at noon: thus the civil date Oct. 1st, 3 P.M., is the astronomical date Oct. 1st, 3^h; but 11 A.M. on this day, civil date, is the astronomical date Sept. 30th, 23^h.

In most cases it is necessary to refer to the astronomical time at Greenwich, or the *Greenwich Date*, No. 481, because it is for the time at this meridian that the elements of astronomical calculations, which are in perpetual change, are given in the Nautical Almanac.

The Greenwich Date is always *mean time*, unless the contrary be expressed. At sea, however, it is often convenient to deduce the Greenwich Date in App. Time.

* The term *Greenwich Date*, used always by Dr Inman, is preferable to *Greenwich Time*, because it is essential to note the day as well as the hour.

† The reason of these rules will appear on considering that dividing 360° into 24^h gives 15° for 1 hour, 15′ for 1^m, and 15″ for 1^s; and further, that to multiply by 60, and at the same time to divide by 15, is the same as to multiply by 4; and to multiply by 15 and to divide by 60 is to divide by 4.

575. To find the Greenwich Date by the Chronometer:—
Since the chronometer is regulated to Greenwich mean time, apply the gain or loss up to the time proposed. No example is necessary, as this is no more than the common process of allowing for the error of a watch.

576. To find the Greenwich Date without the Chronometer:—
(1.) In W. Long. Find the Astron. Date, No. 574; *add* to it the Long. converted into time, No. 570. If the sum amounts to or exceeds 24^h, deduct 24^h and reckon the time on the *next day*.

Ex. 1. June 3d, at $3^h\ 30^m$ P.M., long. 31° W.: find the Greenwich Date.

Astron. Date, June 3d,		$3^h\ 30^m$
	31°,	+2 4
Greenwich, June 3d,		5 34

Ex. 2. June 4th, $5^h\ 18^m$ A.M., long. 130° W.: find the Greenwich Date.

Astron. Date, June 3d,		$17^h\ 18^m$
	130°,	+8 40
		25 58
Greenwich, June 4th,		1 58

(2.) In E. Long. Find the Astronomical Date, No. 574; *subtract* from it the Long. in time: the remainder is the Greenwich Date. If the Long. be greater than the Astron. Date, add 24^h to this last, and reckon the time on the *preceding day*.

Ex. 3. April 15th, $4^h\ 17^m$ P.M., long. 28° E.

Astron. Date, 15th,		$4^h\ 17^m$
	28°,	−1 52
Greenwich, April 15th,		2 25

Ex. 4. Dec. 31st, $6^h\ 57^m$ A.M., long. 40° E.

Astron. Date, 30th,		$18^h\ 57^m$
	40°,	−2 40
Greenwich, Dec. 30th,		16 17

(3.) When it is noon at the place. In W. Long. the Greenwich Date is the Long. in time. In E. Long. take the Long. in time from 24^h: the remainder is the Greenwich Date on the *preceding day*.

Ex. 5. February 13th, noon, long. 122° W.

Greenwich, Feb. 13th, $8^h\ 8^m$ P.M.

Ex. 6. March 31st, long. 91° E.

Long.	$6^h\ 4^m$
Greenwich, March 30th,	17 56

577. It is easy to perceive, on all occasions, what the Greenwich Date must be, by proceeding from noon at the place.

Thus, in Ex. 2, when it is noon in 130° W., it is $8^h\ 40^m$ *later* at Greenwich; hence, when it is $6^h\ 42^m$ *before* noon at this place, it is $6^h\ 42^m$ before $8^h\ 40^m$, or $1^h\ 58^m$ P.M. at Greenwich, on the same day.

Ex. 4. When it is noon in long 40° E., it is $2^h\ 40^m$ *before* noon at Greenwich; hence, when it is $6^h\ 57^m$ A.M., or $5^h\ 3^m$ before noon at this place, it wants $2^h\ 40^m$ and $5^h\ 3^m$, or $7^h\ 43^m$ of noon at Greenwich on this day; or it is $16^h\ 17^m$ on the day before.

II. Reduction of the Elements in the Nautical Almanac.

578. This Reduction is effected by Inspection, or by Logarithms, No. 597. When extreme precision is required, a further correction is necessary, on account of 2d Differences, No. 598.

1. *Reduction by Inspection.*

[1.] *The Sun's Declination.*

579. *At Sea.*—(1.) At noon. Take out of the Nautical Almanac, p. I., or Table 60, the sun's decl. at noon of the day, and note whether it is increasing or decreasing; take out of Table 19 the correction for long., and apply it, as there directed, to the decl. at noon.

If the correction, when *subtractive*, exceed the decl. at noon in the table, the difference is the decl. of the *contrary* name.

Ex. 1. Nov. 13th, 1902, long 64° W.: find the decl at noon.

Sun's decl. 13th, noon,	17° 48′ S. (*incr.*)	
64° W. Table 19	+ 3	
RED. DECL.	17 51 S.	

Ex. 2. March 20th, 1902, long. 178° W.: find the Sun's decl. at noon.

Decl. 20th, noon	0 25′ S. (*decr.*)	
178° W. Table 19	− 12	
RED. DECL.	0 13 S.	

Ex. 3. June 20th, 1902, long. 120° W.: find the decl. at noon.

Decl. 20th, noon,	23° 26′ N. (*incr.*)	
120° W. Table 19	0	
RED. DECL.	23 26 N.	

Ex. 4. Sept. 22d, 1902, long. 167° W.: find the Sun's decl. at noon.

Decl. 22d, noon,	0° 35′ N. (*decr.*)	
167° W. Table 19	− 11	
RED. DECL.	0 24 N.	

Ex. 5. Aug. 6th, 1902, long. 85° E.: find Sun's decl. at noon.

Decl. 6th. noon,	16° 54′ N. (*decr.*)	
85° E. Table 19	+ 4	
RED. DECL.	16 58 N.	

Ex. 6. March 20th, 1902, long. 80° W.: find Sun's decl. at noon.

Decl. 20th. noon,	0° 25′ S. (*decr.*)	
80° W. Table 19	− 5	
RED. DECL.	0 20 S.	

When the declination at noon at Greenwich is 0° 0′ in *east* long., the correction is the decl. of the same name as that of the day *before*; in *west* long. the correction is the decl. of the same name as that of the day *after*.

(2.) At a given hour. Correct for long. as above, and then apply the correction for the hour.

Ex. 1. March 21st, 1902, long. 123° W. at 3^h P.M: find the decl.

Decl. 21st, noon,		0° 1′ S. (*decr.*)
123 W.	+ 8′	+ 11
3^h	+ 3′	
RED DECL.		0 10 N.

For 3^h A.M. the corr. will be for 9^h, or 9′, *subtractive*, and the DECL. is 0° 2′ S.

Ex. 2. Feb. 12th, 1902, long. 78° E. at 7^h 50^m P.M.: find the decl.

Decl. 12th, noon,		13° 54′ S. (*decr.*)
78° E.	+ 4′	− 2
7^h 50^m	− 6′	
RED DECL.		13 52 S.

For 7^h 50^m A.M. the corr. is that for 4^h 10^m, or 3′, *additive*, and the DECL. is 14° 1′ S.

580. *Accurately.*—(1.) Find the Greenwich Date.* Take out of the Nautical Almanac, p. II., the decl. for noon of the same and the next days, and take the diff. between them, or the Daily Variation.

When the declination changes its name, the daily variation is the *sum* of the two declinations.

(2.) With the Greenwich Date and daily variation take out the proportional part from Table 21.

* When the Greenwich Date is given in Apparent Time, the Sun's decl., &c., are taken from p. I. of the Naut. Alm. instead of p. II.; the computation in other respects is the same.

The reduction of the elements in the Nautical Almanac can also be effected by using the Hourly Variation given on p. I. of each month: taking care always to use the elements for the noon or hour nearest to the Greenwich Date. Several examples given under Nos. 579-584, and 592 are thus worked:—

1. *Reduction by Hourly Variation in Nautical Almanac.*

579. [1.] *The Sun's Declination.*

Ex. 1. Nov. 13th, 1878, long. 64° W.: find the decl. at noon.

Long. 64° W. = $4^h\ 16^m = 4^h{\cdot}3$
Hourly Var. $39''{\cdot}7 \times 4{\cdot}3 = 171''$ or $+3'$.
Sun's decl. 13th. noon, 18° 1′ S. (*incr.*)
64° W. Table 19 + 3
RED. DECL. 18 4 S.

Ex. 4. Sept. 22d, 1878, long. 167° W.: find the Sun's decl. at noon.

Long. 167° W. = $11^h\ 8^m = 11^h{\cdot}1$
Hourly Var. $58''{\cdot}5 \times 11{\cdot}1 = 649''$ or $-11'$.
Decl. 22d. noon, 0° 16′ N. (*decr.*)
167° W. Table 19 − 11
RED. DECL. 0 5 N.

(2.) At a given hour.

Ex. 1. March 21st, 1878, long. 123° W., at 3^h P.M.: find the decl.

Long. 123° W. = $8^h 12^m + 3^h = 11^h 12^m = 11^h{\cdot}2$.
Hourly Var. $59''{\cdot}1 \times 11{\cdot}2 = 663''$ or $+11'$.
Decl. 21st, noon, 0° 18′ N. (*incr.*)
123° W. + 8′ } + 11
3^h + 3′ }
RED. DECL. 0 29

For 3^h A.M. the corr. will be for 9^h, or 9′, *subtractive*, and the DECL. is 0° 17′ N.

Ex. 2. Feb. 12th, 1878, long. 78° E., at $7^h\ 50^m$ P.M.: find the decl.

Long. 78° E. = $5^h 12^m - 7^h 50^m = 2^h 38^m = 2^h{\cdot}6$.
Hourly Var. $50''{\cdot}1 \times 2{\cdot}6 = 130''$ or $-2'$.
Decl. 12th, noon, 13° 38′ S. (*decr.*)
78° E. + 4′ } − 2
$7^h\ 50^m$ − 6′ }
RED. DECL. 13 36 S.

For $7^h\ 50^m$ A.M. the corr. is that for $4^h\ 10^m$, or 3′, *additive*, and the DECL. is 13° 45′ S.

580. (3.)

Ex. 1. May 9th, 1878, at $11^h\ 30^m$ mean time at Greenwich: find the Sun's declin.

Hourly Var. $39''{\cdot}5 \times 11^h 30^m$ or $11^h{\cdot}5 = 454''{\cdot}3$
$= +\ 7'\ 34''{\cdot}3$
Decl. 9th, at noon, 17 23 58 ·9 N.
RED. DECL. 17 31 33 ·2 N.

Ex. 2. March 21st, 1878, $15^h\ 27^m$ mean time at Greenwich: find the Sun's decl.

$15^h\ 27^m - 24^h = 8^h\ 33^m$ or $8^h{\cdot}55$.
Hourly Var. 22d, $59''{\cdot}2 \times 8^h{\cdot}55 = 506''{\cdot}2$
$= -\ 8'\ 26''{\cdot}2$
Decl. 22d, at noon, 0 41 42 6 N.
RED. DECL. 0 33 16 ·4 N.

582. [2.] *The Sun's Right Ascension.*

Ex. 1. June 6th, 1878, at $8^h\ 11^m$ A.M., mean time, long 17° W.: required the Sun's R.A.

Astron Time, June, $5^d\ 20^h\ 11^m$
Long. 17° W. + 1 8
Green. Time, June, 5 21 19
$21^h\ 19^m - 24^h = 2^h\ 41^m$ or $2^h{\cdot}7$.
Hourly Var. 6th, $10^s{\cdot}31 \times 2^h{\cdot}7 = -27^s{\cdot}8$
R.A. 6th, 4 57 26 ·4
RED. R.A. 4 56 58 6

Ex. 2. March 22d, 1878, at $2^h\ 20^m$ P.M., mean time, long. 43° E.: required the Sun's R.A.

Astron. Time, March, $22^d\ 2^h\ 20^m$
Long. 43° E. − 2 52
Green. Time, March, 21 23 28
$23^h\ 28^m - 24^h = 0^h\ 32^m$ or $0^h{\cdot}53$.
Hourly Var. 22d, $9^s{\cdot}09 \times 0^h{\cdot}53 = -4^s{\cdot}8$
R.A. 22d, 0 6 24 7
RED. R.A. 0 6 19 9

583. [3.] *The Equation of Time.*

Ex. 2. Nov. 29th, 1878, long. 103° E. at apparent noon: find the Equation of Time.

Astron. Time, Nov. $29^d\ 0^h\ 0^m$
103° E − 6 52
Green. App. T., Nov. 28 17 8
$17^h\ 8^m - 24^h = 6^h\ 52^m$ or $6^h{\cdot}9$.
Hourly Var. 29th, $0^s{\cdot}89 \times 6^h{\cdot}9 = +6^s{\cdot}1$
Equation 29th, at noon, -11^m 30 0
RED. EQ. OF T. − 11 30 1

Ex. 3. Dec. 25th, 1878, long. 18° W. at $5^h\ 0^m$ A.M. (app. time): find the Equation of Time.

Astron. Time, Dec. $24^d\ 17^h\ 0^m$
18° W. + 1 12
Green. Time, Dec. 24 18 12
$18^h\ 12^m - 24^h = 5^h\ 48^m$ or $5^h\ 8$
Hourly Var. 25th, $1^s{\cdot}25 \times 5^h{\cdot}8 = -7^s{\cdot}3$
Equation 25th, at noon, $+0^m$ 20 ·0
RED. EQ. OF T. + 0 12 7

[*To face p.* 208.

(3.) When the first decl. is *increasing*, *add* this prop. part to the decl. at noon; when *decreasing*, *subtract* it.

If the prop. part, when *subtractive*, exceed the decl. itself, the difference is the decl. of the *contrary name*.

Ex. 1. May 9th, 1878, at 11ʰ 30ᵐ mean time at Greenwich: find the Sun's declin.

9th, Page II., N.A.	17° 23′ 58″·9 N.
10th,	17 39 47 ·4 N.
Daily Var.	15 48 ·5
11ʰ 30ᵐ, var. 15′ 30″	7 25 ·6
18·5	8 ·9
	+ 7 34 ·5
9th, at noon,	17 23 58 ·9 N.
Red. Decl.	17 31 33 ·4 N.

Ex. 2. March 21st, 1878, 15ʰ 27ᵐ mean time at Greenwich: find the Sun's declin.

21st, Page II., N.A.	0° 18′ 2″·4 N.
22d,	0 41 42 ·6 N.
Daily Var.	23 40 ·2
15ʰ 0ᵐ, var. 23′ 30″	14 41 ·2
10 ·2	6 ·4
27ᵐ, 23 40	26 ·6
	+ 15 14 ·2
21st, at noon,	0 18 2 ·4 N.
Red. Decl.	0 33 16 ·6 N.

The sun's decl. changes nearly 1′ an hour, or 1″ in 1ᵐ, in March and Sept.; hence, to ensure it to 1″ in the extreme case, the Greenwich Date must be true to 1ᵐ.

The 2d. diff. (see No. 598) is 26″ a-day in June and December. The greatest error of omitting it is then $\frac{1}{8}$ of 26″, or 3″.

[2.] *The Sun's Right Ascension.*

581. *Approximately.*—Find it in the Nautical Almanac, or from Sidereal Time in Table 61, for noon. *See* Note to p. 211 and p. 421.

Ex. 1901, April 21st, find the Sun's Right Ascension. Sidereal Time, April 21st, 1ʰ 55ᵐ·4 − 1ᵐ·2 Equation of Time = 1ʰ 54·2, Sun's R.A.

582. *Accurately.*—(1.) Find the Greenwich Date. Take out of the Nautical Almanac, p. II., the R.A. for noon of the same day and the next. Take the difference between them, which is the Daily Variation.

When the first R.A. has 23ʰ and the second 0ʰ, add 24ʰ to the second, and subtract the first from it: the remainder is the Daily Variation.

(2.) With the Greenwich Date and the Daily Variation find the proportional part from Table 21.

(3.) *Add* this prop. part to the first R.A.: if the sum exceed 24ʰ, reject 24ʰ.

Ex. 1. June 6th, 1878, at 8ʰ 11ᵐ A.M., mean time, long 17° W.: required the Sun's R.A.

Astron. Time, June,	5ᵈ 20ʰ 11ᵐ
Long. 17° W.	+ 1 8
Green. Time, June,	5 21 19
R.A. 5th, Page II., N.A.,	4ʰ 53ᵐ 19ˢ·2
6 h,	4 57 26 ·4
Daily Var.	4 7 ·2
21ʰ 0ᵐ, var. 4ᵐ 0ˢ	3 30
7 ·2	6 ·3
19ᵐ, 4 7	3 ·3
Corr.	+ 3 39 ·6
5th, R.A.	4 53 19 ·2
Red. R.A.	4 56 58 ·8

Ex. 2. March 22d, 1878, at 2ʰ 20ᵐ P.M., mean time, long. 43° E.: required the Sun's R.A.

Astron. Time, March,	22ᵈ 2ʰ 20ᵐ
Long. 43° E.	− 2 52
Green. Time, March,	21 23 28
R.A. 21st, Page II., N.A.,	0ʰ 2ᵐ 46ˢ·4
22d,	0 6 24 ·7
Daily Var.	3 38 ·3
23ʰ 0ᵐ, var. 3ᵐ 30ˢ	3 21 ·2
8·3	8 ·0
28ᵐ, 3 38	4 ·2
	+ 3 33 ·4
21st, noon,	0 2 46 ·4
Red. R.A.	0 6 19 ·8

When the R.A. in the tables is 0, the prop. part is R.A. required.

The greatest daily change of R.A. is $4^m\ 30^s$ in December; the smallest, $3^m\ 30^s$ in September.

[3] *The Equation of Time.*

583. *At Sea.*—(1.) Find the Greenwich Date. Take out the equation of time from the Nautical Almanac, p. I., or Table 62, for the same day and the next. When both the equations are directed to be added, or both to be subtracted, take their difference: if one is to be added and the other subtracted, take the sum: the result is the Daily Variation.

(2.) With the Greenwich Date and the Daily Variation find the correction or proportional part by Table 21.

(3.) When the first Equation is *increasing*, *add* the prop. part; when *decreasing*, *subtract* the lesser from the greater.

If the prop part, when subtractive, exceed the first Equation, their diff. is the Reduced Equation, and is *additive* or *subtractive* according to the direction for the second Equation.

Ex. 1. June 25th, 1902, long. 41° W. at $3^h\ 28^m$ P.M. (app. time): find the Equation of Time.

Astron. Time, June,	$25^d\ 3^h\ 28^m$
41° W.	+2 44
Green. Time, June,	25 6 12
Eq. T. 25th,	$+2^m\ 11^s{\cdot}0$
26th,	+2 24 ·0
Daily Var.	13 ·0
$6^h\ 12^m$, var 13^s	+3 ·0
25th, noon,	2 11 ·0
Red. Eq. of T.	+2 14 ·0

Ex. 2. Nov. 29th, 1902, long. 103° E. at apparent noon: find the Equation of Time.

Astron. Time, Nov.	$29^d\ 0^h\ 0^m$
103° E.	−6 52
Green. App. T. Nov.	28 17 8
Eq. T. 28th,	$11^m 50^s{\cdot}0$
29th,	11 29 ·0
Daily Var.	21 ·0
$17^h\ 8^m$, var 21^s	−15 ·1
28th, noon.	−11 50 ·0
Red. Eq. of T.	−11 34 ·9

Ex. 3. Dec. 26th, 1902, long. 18° W. at $5^h\ 0^m$ A.M. (app. time): find the Equation of Time.

Astron. Time, Dec.	$25^d\ 17^h\ 0^m$
18° W.	1 12
Green Time, Dec.	25 18 12
Eq. T. 25th,	$-0^m\ 8^s{\cdot}6$
26th,	+0 21 ·3
Daily Var.	0 29 ·9
$18^h\ 12^m$, var. $29^s{\cdot}9$	− 22 ·7
25th, noon,	−0 8 ·6
Red. Eq. of T.	+0 14 ·1

Ex. 4. Sept. 1st, 1902, long. 84° E. at $4^h\ 34^m$ A.M. (app. time) find the Equation of Time.

Astron. Time, Aug.	$31^d\ 16^h\ 34^m$
84° E.	−5 36
Green. App. T. Aug.	31 10 58
Eq. T. 31st,	$+0^m\ 28^s{\cdot}3$
32d,	0 9 ·7
Daily Var.	18 ·6
$10^h\ 58^m$, var. $18^s{\cdot}6$	−8 ·5
Eq. T. 31st,	0 28 ·3
Red. Eq. of T.	+0 19 ·8

As the Equation of Time is generally required for a particular hour, the above method by Table 21 is more convenient that that by Table 20, in which the correction is given corresponding to the longitude, and the time at ship, without reference to the time at Greenwich. The first example worked by Table 20 will stand thus (no further explanation being necessary, as the table is entered precisely like Table 19):—

Ex 1. June 25th, 1878, long. 41° W. at $3^h\ 28^m$ P.M.

Eq. T. 25th, p. I., N.A.		$+2^m\ 18^s.5$
26th,		+2 31 ·2
Daily Var.		12 ·7
41° W.	$+1^s.4$	
$3^h\ 28^m$	+1 ·8	+ 3 ·2
Eq. 25th.		+2 18 ·5
RED. EQ. OF T.		+2 21 ·7

Ex. 2. March 26th, 1878, long. 109° E. at $7^h\ 42^m$ A.M. (app. time).

Astron. Time, March $25^d\ 19^h\ 42^m$		
Eq 25th,		$+6^m\ 4^s.2$
26th,		+5 45 ·7
Daily Var.		18 ·5
$12^h\ 0^m$	$-9^s.2$	
7 42	−5 ·9	−9 ·5
109° E.	+5 ·6	
25th, noon,		+6 4 ·2
RED. EQ. OF T.		+5 54 ·7

584. *Accurately.*—Proceed as directed in No. 583, with more attention to precision in the several quantities.

Ex. 1. Green. Date, June 25th, 1878, $6^h\ 11^m$ (app. time): find the Equation of Time.

Eq. 25th, page I., N.A.	$2^m\ 18^s.5$
26th,	2 31 ·2
Daily Var.	12 ·7
$6^h\ 0^m$, var. $12^s.7$	3 ·2
11^m, do.	·1
	+ 3 ·3
Eq. 25th,	+2 18 ·5
RED. EQ. OF T.	+2 21 ·8

Ex. 2. Green. Date, Dec. 24th 1878, $15^h\ 49^m$ (app. time): find the Equation of Time.

Eq. 24th. N.A.	$-0^m\ 10^s.0$
25th.	+0 20 ·0
Daily Var.	30 ·0
$15^h\ 30^m$, var. 30^s	19 ·4
19^m, do.	·4
	−19 ·8
24th, Eq.	−0 10 ·0
RED. EQ. OF T.	−0 9 ·8

[4.] *The Sidereal Time.**

585. Take from Table 23 the Acceleration corresponding to the hours, minutes, and seconds of the Greenwich Date; *add* them to the Sidereal Time at the preceding mean noon, from N A or Table 61. When the sum exceeds 24^h, reject 24^h.

Ex 1. Green. Date, Nov. 1st, 1901, $3^h\ 41^m\ 39^s$: find the Sid. Time. By Tables 61 and 23.

Sid. T. mean noon, Nov. 1st,	$14^h\ 40^m.3$
Accel. 3^h	·5
41^m	·1
39^s	·0
RED. SID. TIME	14 40 ·9

Ex. 2. Green. Date, March 23rd, 1901, $20^h\ 36^m\ 57^s$: find the Sid. Time. By N.A.

Sid. T mean noon, March 23d,	$0^h\ 1^m\ 7^s.0$
20^h	3 17 ·1
36^m	5 ·9
57^s	·2
RED. SID. TIME	0 4 30 ·2

[5.] *The Moon's Horizontal Parallax.*

586. *At Sea.*—As the Moon's Horizontal Parallax does not change more than 27″ in 12 hours, it may be, in most cases, taken out of the Nautical Almanac at sight.

587. *Accurately.*—(1.) Find the Greenwich Date. When the Greenwich time is less than 12^h, take out the hor. par. for the noon and midnight of the given day; when it exceeds 12^h, take out the quantities for the midnight of the same day and the noon of the next. Take the difference between them, which is the variation in 12 hours.

* The Sun's Right Ascension may be found roughly thus:—To the Sidereal Time in Table 61 apply the Eq of Time from Table 62, as there directed: for ex., the Sidereal Time on Nov. 1st, 1901, is $14^h\ 40^m.3$, the Eq. of Time is $16^m\ 3$ *sub.*; hence, *subtracting* $16^m.3$ from $14^h\ 40^m.3$, gives $14^h\ 24^m$, the Sun's R A. required.

(2.) Enter Table 21 with the Greenwich Time and the 12-hourly var., and take out the proportional part. When the horizontal parallax is *increasing*, *add* this prop. part; when *decreasing*, *subtract* it from the horizontal parallax at the preceding noon or midnight.

Ex 1. Green. Date, Jan. 15th, 1878, $5^h 11^m$: required the Hor. Par.

H.P. 15th, noon,	57′ 45″·2
15th, midn.	58 12 ·7
Var. in 12^h,	27 ·5
$5^h 11^m$, var. 27″·5	+11 ·9
15th, noon,	57 45 ·2
RED. HOR. PAR.	57 57 ·1

Ex. 2. Green. Date, Aug. 12th, 1878, $15^h 28^m$: required the Hor. Par.

H.P. 12th, midn.	54′ 56″·9
13th, noon,	54 45 ·9
Var. in 12^h,	11 ·0
$3^h 28^m$, var 11″·0	−3 ·2
12th, midn.	54 56 ·9
RED. HOR. PAR.	54 53 ·7

When necessary to correct for latitude (No. 437), see Table **41**.

592. [9.] *Right Ascension of Venus.*

Ex. 3. Green Date, Sept. 11th, 1903, $11^h 47^m$: find Venus' R.A.

R.A. Sept. 11th, noon	$11^h 37^m 18^s·8$
Hourly Var.* 11th,	
$5^s·1 \times 11^m·8$	1 0 ·2
RED. R.A. VENUS	11 36 18 ·6

Ex. 4. Green. Date, May 5th, 1903, $22^h 47^m$: find Venus' R.A.

R.A. May 5th, noon	$5^h 17^m 49^s·3$
Hourly Var.* 5th,	
$12^s·9 \times 22·8$	4 54 ·1
RED. R.A. VENUS	5 22 43 ·4

593. [10.] *Declination of Venus.*

Ex. 1. Green. Date, Sept. 11th, 1903, $11^h 47^m$: find Venus' Declination.

Hourly Var.* Sept. 11th	
$23''·9 \times 11^h 47^m$ =	−4′ 42″·0
Decl. Venus, Sept. 11th,	6° 51 30 ·0
RED. DECL. VENUS	6 46 48 ·0

Ex. 2. Green. Date, Sept. 11th, 1903, $11^h 47^m$: find Venus' Declination.

Decl. Sept. 11th,	6° 51′ 30″·0
„ Sept. 12th,	6 41 53 ·7
Daily Var.	9 36 ·3
$11^h 30^m$, var. 9 30	4 33 ·1
6·3	2 ·9
17^m, 9 36·3	6 ·9
	−4 42 ·9
Decl. Venus, Sept. 11th,	6 51 30 ·0
RED. DECL. VENUS	6 46 47 ·1

* The Hourly Variations are taken from the Planetary Ephemerides at Transit in the Nautical Almanac.

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of the name of the next hour.

590. *Accurately.*—Employ the decimals of the diff. for 10^m as whole seconds, taking care to divide the prop. part corresponding by 10, or by 100. Proceed as above directed in No. 589, (1) and (3); also take the seconds of the Greenwich Date as minutes, taking care to put the minutes of the prop. part into the place of the seconds,

and the seconds into that of thirds: it is near enough to work to the fraction of 1^m.

Ex. 1. Green. Date, Aug. 16, 1878, $17^h 38^m 20^s$: find the Moon's declin.

Decl. 17^h,	8° 10′ 3″·2 N. *incr.*	D. 130″·28
10^m: 130″·28 :: $38\frac{1}{3}^m$	+ 8 19 ·4	
Red. Decl.	8 18 22 ·6 N.	

Ex. 2. Green. Date, Jan. 22d, 1878, $4^h 31^m 45^s$: find the Moon's declin.

Decl. 4^h,	0° 15′ 27″·7 N. *dec.*	
10^m: 170″·92 :: $31\frac{3}{4}^m$	− 9 2 ·7	
Red. Decl.	6 25 0 N.	

The greatest change of decl. in 1 hour is 17′; hence, to obtain the decl. in the extreme case, true to 1′, the Greenwich Date must be true to 4^m, or 1° of long.; and to obtain it to 1″, the Greenwich Date must be true to 4^s, in the extreme case.

[8.] ***The Moon's Right Ascension.***

591. Take the diff. of R.A. for 1^h. To the const. 9·5229 add the prop. log. of the diff. for 1^h, and the prop. log. of the minutes and seconds of the Greenwich Date: the sum is the prop. log. of the proportional part, always *additive*.

When the sum exceeds 24^h, reject 24^h.

Ex. 1. Green. Date, Feb. 2d, 1878, $1^h 17^m 15^s$: find the Moon's R.A.

R.A. 1^h,	$21^h 11^m 45^s·3$	
2^h,	21 13 41 ·3	9·5229
Var. 1^h,	1 56 ·0	1·9690
Time,	17 15	1·0185
	+ 0 33 ·3	2·5104
R.A. 1^h,	21 11 45 ·3	
Red. R.A.	21 12 18 ·6	

Ex. 2. Green. Date. April 28th, 1878, $16^h 56^m 45^s$. find the Moon's R.A.

R.A. 16^h,	$23^h 58^m 54^s·6$	
17^h,	0 0 40 ·4	9·5229
Var. 1^h,	1 45 ·8	2·0089
Time,	56 45	·5013
	1 40	2·0331
R.A. 16^h,	23 58 54 ·6	
Red. R.A.	0 0 34 ·6	

The greatest change in 1^h is $2^m 55^s$, the smallest is $1^m 45^s$; hence to have the result true to 1^s, the Greenwich Date must be true to 20^s.

[9.] ***Right Ascension of Venus.***

592. With the Green. Date and daily variation of R.A. deduce the prop. part by Table 21; this is to be *added* to the R.A. at the preceding noon when *increasing*, and *subtracted* when *decreasing*.

Ex. 1. Green. Date, Sept. 11th, 1903, $11^h 47^m$: find Venus' R.A.

R.A. Sept. 11th,		$11^h 37^m 18^s·8$
Sept. 12th,		11 35 13 ·3
Daily Var.		2 5 ·5
$11^h 30^m$, var. $2^m 0^s$		0 57 ·5
	5 ·5	2 ·4
17^m,	2 5 ·5	1 ·4
		1 1 ·3
R.A. Sept 11th,		11 37 18 ·8
Red. R.A.		11 36 17 ·5

Ex. 2. Green. Date, May 5th, 1903, $22^h 47^m$: find Venus' R.A.

R.A. May 5th,		$5^h 17^m 49^s·3$
May 6th,		5 22 58 ·6
Daily Var.		5 9 ·3
$22^h 30^m$, var. 5^m		4 41 ·2
	9·3	8 ·4
17^m,	5 9 ·3	3 ·6
		4 53 ·2
R.A. May 5th,		5 17 49 ·3
Red. R.A.		5 22 42 ·5

The greatest daily change of R A. is 6^m.

[10.] *Declination of Venus.*

593. Find the proportional part, and apply it to the declin. at the preceding noon, as directed in No. 580. As the process, whether Approximate or Accurate, is the same as that for the sun, no example is necessary.

The greatest daily change of declination is 35′.

[11.] *Right Ascension and Declination of Mars.*

594. Proceed as for Venus. The greatest daily change of R.A. is 4^m; that of declination, 25′.

[12.] *Right Ascension and Declination of Jupiter.*

595. Proceed as for Venus. The greatest daily change of R.A. is 1^m; that of declination, 4′.

[13.] *Right Ascension and Declination of Saturn.*

596. Proceed as for Venus. The greatest daily change of R.A. is 40^s; that of declination, 2′.

2. *Reduction by Logarithms.*

597. (1.) The proportional part may be found by the Proportional Logarithms, Table 74, thus:— For 24-hourly variations take the constant log. 9·1249; for 12-hourly variations take 8·8239; for 3-hourly variations, no constant; and for hourly variations, 9·5229.

Then to the constant add the prop. log. of the Green. Date, (reading hours and min. as min. and sec. when the var. corresponds to more than 3^h), and the prop. log. of the variation as given for 24^h, 12^h, 3^h, or 1^h; the sum is the prop. log. of the proportional part required.

Ex. 1. (Daily Variation.) Green. Time $11^h\ 30^m$, Daily Var. 14′ 42″.

	const. log.	9·1249
Gr. Time $11^h\ 30^m$	p. log.	1·1946
Var. 14′ 42″	p. log.	1·0880
Prop. Part 7′ 2″·6	p. log.	1·4075

Ex. 2. (Twelve-hourly Var.) Green. Time $4^h\ 11^m$, Var. 16″·6.

	const. log.	8·8239
Gr. Time $4^h\ 11^m$	p. log.	1·6337
Var. 16″·6	p. log.	2·8133
Prop. Part 5″·8	p. log.	3·2709

Ex. 3. (Three-hourly Var.) Green. Time $7^h\ 18^m\ 12^s$, change in 3 hours 1° 31′ 41″: find the Prop. Part for $1^h\ 18^m\ 12^s$.

Gr. Time $1^h\ 18^m\ 12^s$	p. log.	3621
Var. 1° 31′ 41″	p. log.	2930
Prop. Part 0° 39′ 49″	p. log.	6551

Ex. 4. (Hourly Var.) Green. Time $10^h\ 56^m\ 10^s$, Hourly Var. 8′ 47″·2.

	const. log.	9·5229
Gr. Time $56^m\ 10^s$	p. log.	·5058
Var. 8′ 47″·2	p. log.	1·3114
Prop. Part 8′ 13″·5	p. log.	1·3401

(2.) The proportional part for 24^h is obtained conveniently from Table 21 A;* thus:—

* In common practice at sea the prop. part may be taken out at sight from Table 21: when extreme precision is required the logarithms to four places only are not sufficient. For ex., at sea, for the Time $7^h\ 10^m$, and Daily Variation 22′ 27″·5, we enter the table with 22′ 30″, and take out at once (No. 50) the quantity about ⅓ between 6′ 33″·7 at $7^h\ 0^m$, and 7′ 1″·9 at $7^h\ 30^m$, that is, 6′ 40″, or 6′·7. Now this mental interpolation is performed in very considerably less time than it takes to write down the quantities, while the small inaccuracy to which it is liable, amounting here to 6′ 42″·4 − 6′ 40″, or 2″·4 only, would be wholly inappreciable in practice at sea. The logarithms in Table 21 A give in this case the result true to 0″·1; but if the prop. part were above 8′ the logs. could no longer be depended

Take out from this Table the log. of the Greenwich Time, and add to it the log. of the Daily Variation; the sum is the log. of the prop. part required.

Ex. 1. (The Sun's Declination.) Green. Date, May 13th, $11^h\ 30^m$.

Gr. Time	$11^h\ 30^m$	log.	3195
Daily Var.	$14'\ 42''$	log.	2129
Prop. Part	$7'\ 2''\cdot 6$	log.	5324

Ex. 2. (The Sun's Right Ascension.) Green. Date, June 6th, $9^h\ 19^m$.

Gr. Time	$9^h\ 19^m$	log.	4109
Daily Var.	$4^s\ 7^s\cdot 5$	log.	7648
Prop. Part	$1^m\ 36^s$	log.	1·1757

Ex. 3. (The Equation of Time.) Green Date, June 25th, $6^h\ 11^m$.

Gr. Time	$6^h\ 11^m$	log.	5890
Daily Var.	12^s	log.	3010
Prop. Part	3^s	log.	8900

Ex. 4. (Right Ascension of Venus.) Green. M T. $19^h\ 13^m$, Daily Var. $4^m\ 54^s$.

Gr. Time	$19^h\ 13^m$	0965
Daily Var.	$4^m\ 54^s$	6900
Prop. Part	$3^m\ 55^s$	7865

3. *Correction for Second Differences.*

598. The quantities in the Nautical Almanac do not in general change uniformly, that is, by equal portions in equal times, but the differences of any series of quantities taken in order exhibit differences among themselves, or *second differences*, as in the case of alts., p. 200. Hence the proportional part found by the preceding rules is not always the *actual change* in the interval, but may require a correction, which is called the *equation of second differences.*

The greatest error which can arise in any case from neglecting this correction, that is, the greatest value of the equation itself, is $\frac{1}{8}$ of the whole 2d diff.; this takes place when the interval for which the proportional part is required is *half* the interval for which the quantities are set down in the table.

For example, suppose the second diff. of the sun's decl. to be 26″ in 24^h; the greatest error of neglecting the equation will be 1-8th of 26″, and will take place when the Green. Date is 12^h, or midnight.

599. To find the Equation of Second Differences. Take the two quantities in the table next on each side of the given one, and set them down in order. Add together the 1st and 4th, and the 2d and 3d; write against the sum of the 2d and 3d, whether it be the *greater* or the *lesser* of the two sums.

Half the diff. of these two sums is the 2d diff.

Under the Tabular Interval, and with the Green. Date as intermediate time, enter Table 25 and take out the multiplier, by which multiply the 2d diff.; this is the Equation of 2d differences. If the 2d sum is marked the *greater*, *add* the equation to the prop. part deduced by one of the preceding rules; if the *lesser*, *subtract* the equation.

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upon as shewing the true tenth, not only because the last figure ceases to change by lat. $7^h\ 58^m$, but because the last figure of any logarithm is itself but an approximation.

Although logarithms afford material service in multiplication or division of many figures, yet in short and easy reductions they are attended, as is well known to experienced arithmeticians, with considerable loss of time, and should accordingly be resorted to only when they unequivocally effect a saving of time and labour.

It is also important to observe that the faculty of mental interpolation constantly improves by exercise, and that the habit sharpens the perception of arithmetical proportions.

By Logarithms. To the prop. log. of the 2d diff. add the ar. co. log. of the multiplier; the sum is the prop. log. of the equation required.

Ex. Greenwich Date, June 17th, 1878, $13^h\ 11^m$ M.T.: find the Sun's Declination.

The two declinations preceding are those of the 16th and 17th; the two following are those of the 18th and 19th.

June 16th,	23° 22 3″·5
17th,	23 23 57 ·3
18th,	23 25 26 ·3
19th,	23 26 30 ·6
	46 48 34 ·1
	46 49 23 6 (*greater*)
	2) 49 ·5
2d Diff.	24 ·75

In Table 25, Tabular Interval 24^h and $13^h\ 11^m$ give ·124.

This multiplied by 24·75 gives 3″·07, the EQUATION of 2d DIFFS.; which being added to prop. part as found by No. 580, gives DECLIN. required.

By Logs.

24″·75	p. log.	2·6400
Log. 9·0925	ar. co.	0·9075
	p. log.	3·5475

600. This correction is of the most importance when the quantity attains its *maximum*, that is, arrives at its greatest amount between two times given in the Nautical Almanac. This circumstance is known thus:—When the sum of the vars. in 1 hour opposite the Green. day and the following one is equal to the diff. of the vars. in 1 hour opposite the Greenwich day and the preceding one; for ex. on Dec. 20th, 21st, and 22d, the vars. in 1 hour of the sun are 1″·70, 0″·52, and 0″·66 respectively, hence the declin. is maximum at some time between the noons of the 21st and 22d.

III. CONVERSION OF TIMES.

1. *Intervals.*

[1.] *To convert an Interval of Mean Time into an Interval of Sidereal Time.*

601. *Approximately.*—Increase the Interval by 1^m for every 6 hours, or by 10^s for each hour, or by 1^s for every 6^m.

602. *Accurately.*—*Add* to the Interval the *Acceleration* (Table 23), corresponding to the hours, minutes, and seconds.

Ex. 1. (Approximately.) Convert $7^h\ 12^m\ 6^s$ of M.T. into S.T.

	$7^h\ 12^m\ 6^s$
70^s and 2^s	+ 1 12
INTERV. IN SID. T.	7 13 18

Ex. 2. (Accurately.) The same ex.

		$7^h\ 12^m\ 6^s$
7^h	$1^m\ 8^s·99$	
12^m	1 ·97	+ 1 10 ·98
6^s	·02	
INTERV. IN SID. T.		7 13 16·98

[2.] *To convert an Interval of Sidereal Time into an Interval of Mean Time.*

603. *Approximately.*—Diminish the Interval by 1^m for every 6 hours, or by 10^s for each hour, or by 1^s for every 6^m.

604. *Accurately.*—*Subtract* from the Interval the *Retardation** (Table 24), corresponding to the hours, minutes, and seconds.

* Or from corresponding tables in Naut. Almanac.

Ex. 1. (Approximately.) Convert $7^h\ 13^m\ 17^s$ of S.T. into M.T.

	$7^h\ 13^m\ 17^s$
70^s and 2^s	−1 12
INTERV. IN M.T.	7 12 5

Ex. 2. (Accurately.) The same ex. $7^h\ 13^m 17^s$

7^h	$1^m\ 8^s{\cdot}81$	
13^m	2·13	−1 10·99
17^s	·05	
INTERV. IN M.T.		7 12 6·01

The above precepts relate to *Intervals* of time; the following are employed in the conversion of *absolute time* of one kind into that of another.

2. *Absolute Times.*

[1.] *To convert Apparent Time into Mean Time.*

605. Reduce the Equation of Time, taken from page I. of the Nautical Almanac, or from Table 62 by No. 583, or 584, and apply it to the given App. Time as directed in the said page I. or in Table 62.

If the Eq. of T. when subtractive exceeds the A.T., add 24^h to the A.T. and date the time on the day before.

Ex. 1. March 2d, 1902, at $11^h\ 56^m\ 43^s$ A.M., A.T., long. 148 W.: find M.T.

The Green. Date is $2^d\ 9^h\ 49^m$.

Eq. T. 2d,	$12^m\ 27^s{\cdot}8$
3d,	12 15·6
Daily Var.	12·2
$9^h\ 49^m$, var. $12^s{\cdot}2$	−5·1
2d,	12 27·8
Red. Eq. T.	+12 22·7
App. T.	23 56 43
MEAN TIME, 2d	0 9 5·7

Ex. 2. Nov. 10, 1902, $0^h\ 13^m\ 40^s$ P.M., A.T., long. 36° E: required M.T.

Green. Date, $9^d\ 21^h\ 50^m$.

Eq. T. 9th,	$-16^m\ 7^s{\cdot}6$
10th,	−15 2·7
Daily Var.	4·9
$21^h\ 50^m$, var. $4^s{\cdot}9$	−5·0
9th,	16 7·6
	−16 2·6
App. T.	0 13 40·0
MEAN TIME, 9th	23 57 37·4

[2.] *To convert Mean Time into Apparent Time.*

606. Find the Green. Date; reduce to it the Eq. of T. from page II. of the Nautical Almanac, or from Table 62, and apply it to the given M.T. as directed in the said page II., or the *contrary way* to that directed in Table 62.

If the Eq of T. when subtractive exceeds the M.T., add 24^h to the M T. and date the time on the day before.

Ex. 1. Aug. 31st, 1902 long. 18° W., $20^h\ 58^m\ 51^s$ M.T.: find A.T.

Green. Date, M.T., $31^d\ 22^h\ 11^m$.

Red. Eq. T.	$-0^m\ 11^s{\cdot}1$
M.T, 31st,	20 58 51·0
APP. TIME 31st	20 58 39·9

Ex. 2. Feb. 17th, 1902, long. 120° E., $0^h\ 5^m\ 18^s$ M.T.: find A.T.

Green. Date, M.T., $16^d\ 16^h\ 5^m$.

Red. Eq. T.	$-14^m\ 17^s$
M.T.	0 5 18
APP. TIME, 16th	23 51 1

[3.] *To convert Sidereal Time into Mean Time.*

That is, having given the Right Ascension of the Meridian, to find Mean Time.

607. In W. long. *add* the Acceleration for the long. to the Sid. T. at mean noon; in E. long. *subtract* it.

From the given Sid. Time (increased if necessary by 24) subtract this reduced Sid. T. at the preceding noon; the remainder is the approximate M. T.; subtract from this time the Retardation corresponding (Table **24**).

Ex. 1. Jan. 1st. 1878, long. $9^h\ 50^m\ 40^s$ E., at $21^h\ 9^m\ 23^s$ Sid. T.: find M.T.

Sid. T. M. Noon,		$18^h\ 44^m\ 0^s{\cdot}7$	Given Sid. T.	$21^h\ 9^m\ 23^s{\cdot}0$
Accel. 9^h	$1^m\ 28^s{\cdot}7$		Red. Sid. T. M. Noon,	18 42 23·7
50^m	8·2	− 1 37·0	Approx M.T.	2 26 59·3
40^s	·1		Ret. 2^h $19^s{\cdot}7$	
Sid. T. M. Noon,		18 42 23·7	26^m 4·3	−24·2
			59^s 0·2	
			Mean Time,	2 26 35·1

Ex. 2. March 22d, 1878, long. $7^h\ 22^m\ 35^s$ W., at $11^h\ 5^m\ 27^s{\cdot}2$ Sid. T.: find M.T.

The Red Sid. T. is $0^h\ 0^m\ 37^s{\cdot}9$; whence the approx. M.T. is $11^h\ 4^m\ 49^s{\cdot}3$, and the Ret. to this $1^m\ 48^s{\cdot}9$ *sub.* leaves Mean Time $11^h\ 3^m\ 0^s{\cdot}4$.

[4.] *To convert Mean Time into Sidereal Time.*

That is, having given the Mean Time, to find the R.A. of the Meridian.

608. In W. long. *add* the Acceleration for the long. to the Sid. T. at the preceding mean noon; in E. long. *subtract* it.

To this reduced Sid. T. at mean noon add the given M. T. and the Acceleration for the said M.T.; the result (rejecting 24^h if it exceed 24^h) is the Sid. T. required.

Ex. 1. June 29th, 1878, long. $10^h\ 39^m\ 6^s$ W., at $3^h\ 37^m\ 46^s{\cdot}6$ M.T: find Sid. T.

Sid. T. at M. Noon, 29th,		$6^h\ 29^m\ 44^s{\cdot}3$
Accel. for long. $10^h\ 39^m\ 6^s$		+ 1 45·0
Red. S.T. M. Noon,		6 31 29·3
M.T.		3 37 46·6
Accel. 3^h	$29^s{\cdot}6$	
37^m	6·1	+ 35·8
47^s	·1	
Sid. Time,		10 9 51·7

Ex. 2. Nov. 26th, 1878, long $8^h\ 52^m\ 15^s$ E., at $14^h\ 55^m\ 7^s{\cdot}8$ M.T.; find S.T.

Sid. T. M. Noon, 26th,		$16^h\ 21^m\ 7^s{\cdot}6$
Accel for $8^h\ 52^m\ 15^s$		− 1 27·4
Red. S.T. at M. Noon,		16 19 40·2
M.T.		14 55 7·8
Accel. 14^h	$2^m\ 18^s{\cdot}0$	
55^m	9·0	+ 2 27·0
$7^s{\cdot}8$	·0	
		31 17 15·0
Sid Time,		7 17 15·0

IV. Hour-Angles.

1. *To find the Hour-angle, Mean Time being given.*

[1.] *Hour-angle of the Sun.*

609. Find the Green. Date; Reduce to it the Eq. of T., and apply it to the M.T. as directed page II. of the Nautical Almanac, or the contrary way to that directed in Table 62; the result is A.T.

If A.T. is less than 12^h, it is the Sun's Hour-angle, reckoning from the meridian westwards; if A.T. exceed 12^h, subtract it from 24^h: the remainder is the Hour-angle, reckoning from the meridian eastwards

Ex. 1. May 19th, 1878, long. 57° 4′ W., at $3^h\ 7^m\ 46^s$ M.T.: find the Sun's Hour-angle.

The Green. Date is $19^d\ 6^h\ 56^m\ 2^s$.

Eq. T. 19th, Page II.	$+3^m\ 45^s{\cdot}3$
20th,	+3 42·5
	2·8
$6^h\ 56^m$, var. $2^s{\cdot}8$	−·8
	3 45·3
Red. Eq. T.	+3 44·5
M.T	3 7 46·0
Hour-angle,	3 11 30·5

Ex. 2. July 2d, 1878, long. 62° 1′ E., at $20^h\ 26^m\ 53^s$ M.T.: find the Sun's Hour-angle.

The Green. Date is $2^d\ 16^h\ 18^m\ 49^s$.

Eq. T. 2d, Page II.	$3^m\ 43^s{\cdot}9$
3d,	3 55·1
Daily Var.	11·2
$16^h\ 19^m$, var. $11^s{\cdot}2$	+7·7
	3 43·9
Sub. from M.T.	3 51·6
M.T.	20 26 53 0
	20 23 1·4 W.
Hour-angle,	3 30 58·6 E.

610. When the Sun's Hour-angle is required from midnight, if A.T. is less than 12^h, subtract it from 12^h; the remainder is the Hour-angle, reckoned westwards. If A.T. exceed 12^h, subtract 12^h from it; the remainder is the Hour-angle, reckoned eastwards.

[2.] *Hour-angle of a Star.*

611. (1.) Find the Green. Date, to which reduce the Sid. T. at mean noon.

(2.) To the M.T. add this reduced Sid. T., and from the sum (increased if necessary by 24^h) subtract the star's R.A.; the result is the Hour-angle W.

If the Hour-angle exceed 12^h, subtract it from 24^h; the remainder is the Hour-angle E.

Ex. 1. July 21st, 1878, long. 32° 10′ W., at $9^h\ 45^m\ 21^s$ M.T.: required the Hour-angle of Arcturus.

Green. Date, $21^d\ 11^h\ 54^m\ 1^s$.

Sid T. Mean Noon, 21st,	$7^h\ 56^m\ 28^s{\cdot}5$
Accel. 11^h,	1 48·4
54^m,	8·9
Red. Sid. T.	7 58 25·8
M.T.	9 45 21·0
	17 43 46 8
★ R.A.	14 10 8·4
Hour-angle,	3 33 38·4

Ex. 2. Sept. 1st, 1878, long. 169° 57′ E. at $8^h\ 57^m\ 39^s$ M.T.: find the Hour angle of Altair.

Green. Date, Aug. $31^d\ 21^h\ 37^m\ 51^s$.

Sid. T. at M. Noon, 31st,	$10^h\ 38^m\ 7^s{\cdot}3$
Accel. 21^h,	3 27·0
37^m,	6·1
51^s,	·1
Red. Sid. T.	10 41 40·5
M T.	8 57 39 0
	19 39 19 5
★ R.A.	−19 44 53 5
	23 54 26 0 W.
Hour-angle,	0 5 34 0 E.

Ex. 3. Oct. 1st, 1878, long. 92° 48′ E., at $5^h\ 58^m\ 19^s$ M.T.: required the Hour-angle of Markab. Hour-angle, $4^h\ 20^m\ 7^s{\cdot}8$ E.

Ex. 4. Dec. 25th, 1878, long. 86° 45′ W., at $5^h\ 7^m\ 35^s$ M.T.: find Rigel's Hour-angle. Hour-angle, $5^h\ 43^m\ 55^s$ E.

Ex. 5. March 22d, 1878, long. 110° 39′ W., at $11^h\ 3^m\ 37^s$ M.T.: find the Hour-angle of Antares. Hour-angle, $5^h\ 15^m\ 53\ 9^s$ E.

[3.] *Hour-angle of a Planet or the Moon.*

612. (1.) Find the Green. Date, and reduce thereto the Sid. T. at mean noon, and the R.A. of the body.

(2.) Add this reduced Sid. T. to the M.T., and proceed as for a star.

Ex. 1. Oct. 15th, 1878, long. 41° 44′ W., at 6h 56m 54s P.M. M.T.: find the Moon's Hour-angle.

Green. Date, Oct. 15d 9h 43m 50s.

Sid. T. Mean Noon, 15th.			13h 35m 32s·2
Accel. 9h			1 28 ·7
43m			7 ·1
50s			·1
Red Sid. T.			13 37 8 ·1
☾'s R.A. 9h	4 40m 20s·5		
10h	4 42 37 ·5		9·5229
	2 17		1·8967
	43 50		0·6135
	1 39 ·9		2·0331
☾'s R.A. 9h	4 40 20 ·5		
Red. R.A.	4 42 0 ·4		
Red. Sid. T.		13h 37m 8s ·1	
M.T.		6 56 54	
		20 34 2 ·1	
☾'s R.A.		−4 42 0 ·4	
		15 52 1 ·7 W.	
Hour-angle,		8 7 58 ·3 E.	

Ex. 2. Feb. 11th, 1878, long 87° 6′ W., at 4h 46m 48s A.M. M.T.: find the Hour-angle of Mars.

Green. Date, Feb. 10d 22h 35m 12s

Sid. T. Mean Noon, 10th			21h 21m 43s·0
Accel. 22h			3 36 ·8
35m			5 ·8
Red. Sid. T.			21 25 25 ·6
Mars' R.A. 10th	2h 15m 57s·0		
11th,	2 18 22 ·2		
Daily Var.	2 25 ·2		
22h 35m var. 2m 25s gives			2 17 ·1
R.A. 10th			2 15 57 ·0
Red. R.A			2 18 14 ·1
Red. Sid. T.		21h 25m 25s·6	
M.T.		4 46 48 ·0	
		26 12 13 ·6	
Mars' R.A.		−2 18 14 ·1	
		23 53 59 ·5 W.	
Hour-angle,		0 6 0 ·5 E.	

2. *To find the Hour-angle, the Altitude being given.*

613. *By Inspection.* See Explan. of Table 5.

614. *By Computation.* Add together the alt., lat., and pol. dist., take half the sum, and from it subtract the alt.

Add together the log. sec. of the lat., the log. cosec. of the pol. dist., the log. cos. of the half sum, and the log. sine of the remainder; the sum (rejecting tens) is the log. sine square of the Hour-angle.*

Note.—When the Hour-angle is less than 2h, four places of the logarithms give it to the nearest second of time.

Ex. 1. Alt. 37° 51′, lat. 51° 10′ N., pol. dist. 70° 33′, or decl. 19° 27′ N.: find the Hour-angle. See Ex. 1, of No. 615.

Alt.	37° 51′		
Lat.	51 10	.. sec.	0·20269
Pol. dist.	70 33	... cosec.	0·02552
Sum	159 34		
Half	79 47	... cos.	9·24888
Rem.	41 56	... sin.	9·82495
Hour-angle	3h 32m 47s	sin. sq.	9·30204

Ex. 2. Alt. 21° 19′ 5″, lat. 51° 9′ 26″ N. decl. 11° 14′ 44″ S.: find the Hour-angle.

Alt.	21° 19′ 5″			Pts. for ′
Lat.	51 9 26	... sec.	0·202536,	+ 78
P. dist.	101 14 44	.. cosec.	0·008414,	+ 6
	173 43 15			
	86 51 37	... cos.	8·738820,	− 277
	65 32 32	... sin.	9·959167,	+ 2
			8·908937	
			−201	
		* sin. sq.	8·908736	
		2h 12m 19s	707	
		·3	29	
Hour-angle	2 12 19·3			

Ex. 3. Lat. 30° 11′ 24″ N. Decl. 14° 2′ 46″ N. Alt. 61° 9′ 17″. Hour-angle 1h 43m 52s.

When both the lat. and decl. are 0, the zenith distance in time is the measure of the Hour-angle.

At sea it is near enough to take the alt., lat., and pol. dist., to the nearest minute; but if the sum is *odd* and greater that 170°, take the cos. and sin. to 30″, because the neglect of this may make a sensible error in the Hour-angle.

* Log. sine square, Table 69, is the same as the log. haversine of Inman's Tables.

[1.] *Errors of the Hour-Angle.*

615. The following rules give, very nearly, the effect of 1′ error in the alt., lat., and pol. dist., and therefore for any small number of min. or sec. in the like proportion :—

(1.) Error of hour-angle, or time, due to 1′ error of alt.* Add together the parts for 30″ of the cos. and sine: the sum, divided by the parts for 1ˢ (Tab. 69), gives the error required.

When the alt. is too *small*, the hour-angle is too *great;* when the alt. is too *great*, the hour-angle is too *small.*

(2.) Error of hour-angle, or time, due to 1′ error of lat.† Multiply the parts for 30″ of the sec. by 2, and add the parts for the sine; under the sum put the parts for 30″ of the cos., and take the diff.; divide this diff. by the parts for 1ˢ.

When the lat. and true bearing are of the *same* names, the errors of the hour-angle and lat. are of the *same* kind; when of *contrary* names, of *contrary* kinds.

Ex. In N. Lat., if the sun is to the N. of E. or W., and the Lat. employed is too *great*, the computed hour-angle will be too *great;* if the sun is to the S., in the same case too *small.*

(3.) Error of time, or hour-angle, due to 1′ error of pol. dist. Multiply the parts for 30″ of the cosec. by 2, and add the parts for 30″ of the cos.; under the sum put the parts for 30″ of the sine; take the diff., and divide it by the parts for 1ˢ.

When the parts for 30″ of the sine are *less* than the sum over them, the error of the hour-angle is of the *contrary* kind to that of the pol. dist.; when *greater*, of the *same* kind.

Ex. See Ex. 1, of No. 614.

Parts for 30″.	Error 1′ of Alt.	Error 1′ of Lat.	Error 1′ of Pol. Dist.
51° 10′ sec. 78	Cos. 354	Sec. 78	Cosec. 22
70 33 cosec. 22	Sin. 71	× 2	× 2
79 47 cos. 354	(Sum) 425	156	44
41 56 sin. 71	ERROR OF TIME	Sin. 71	Cos. 354
Parts for	$=\frac{425}{64}=7^s$	(Sum) 227	(Sum) 398
1ˢ table 69 p. 830 } 64		Cos. 354	Sin. 71
		(Diff.) 127	(Diff.) 327
		ERROR OF TIME	ERROR OF TIME
		$=\frac{127}{64}=2^s$	$=\frac{327}{64}=5^s$

The error of the hour-angle may, possibly, be made up of the *sum* of these three errors, but in most cases they will partially compensate.

* To find, approximately, the small interval of time corresponding to a small change of alt. by means of the Azimuth :—Add together the log. sine of the change of alt., the log. cosec. of the azim., and the log. sec. of the lat.: the sum (rejecting tens) is the log. sine of the interval required.

To find the same, by means of the Hour-angle :—Add together the log. sine of the change of alt., the log. sec. of the lat. and declin., the log. cos. of the alt., and the log. cosec. of the hour-angle: the sum is the log. sine, as above.

One of these processes may, on some occasions, be convenient.

† To find this error by means of the Azimuth :—Add together the log. cot. of the azim., the log. sec. of the alt., and the log. sine of the error of lat.: the sum is the log. sine of the error required.

3. *To find the Hour-angle, the Azimuth being given.*

616. Add together the log. sine of the azimuth, the log. cos. of the lat., and the log. sec. of the decl.; the sum (rejecting tens) is the log. sine of the angle A.*

Under A put the azimuth, reckoned from the elevated pole, and take half the sum.

Take half the sum of the pol. dist. and colat., and half the diff.

Add together the log. tan. of the half sum of A and the azim., the log. cos. of the half sum of the p. dist. and colat., and the log. sec. of the half diff.; the sum (rejecting tens) is the log. cot. of an arc.

When each half sum is less, or greater, than 90°, twice this arc is the Hour-angle required; but if one only of the half sums exceed 90°, twice the suppl. of the arc is the Hour-angle.

Ex. Lat. 51° 30′ N., decl. 20° 2′ N., azim. N. 110° 21′ W.: find the Hour-angle.

Az.	110° 21′	sin. 9·97201
Lat.	51 30	cos. 9·79415
Decl.	20 2	sec. 0·02711
A	38 25	sin. 9·79327
Az.	110 21	
Sum	148 46, half 74° 23′	

P. Dist.	69° 58′		
Colat.	38 30	74° 23′	tan. 0·55359
Sum	108 28	half 54 14	cos. 9·76677
Diff.	31 28	do. 15 44	sec. 0·01658
		$1^h\ 38^m\ 52^s$	cot. 0·33694
		2	
HOUR-ANGLE,		3 17 44	

4. *To find the Hour-angle, the Altitude and Azimuth being given.*

617. Add together the log. sine of the azim., the log. cos. of the alt., and the log. sec. of the decl.; the sum (rejecting tens) is the log. sine of the Hour-angle.

Ex. Alt. 40° 25′, azim. 69° 39′, decl. 20° 2′: required the Hour-angle.

Az.	69° 39′	sin. 9·97201
Alt.	40 25	cos. 9·88158
Decl.	20 2	sec. 0·02711
HOUR-ANGLE,	$3^h\ 17^m\ 48^s$	sin. 9·88070

5. *To find the Hour-angle on the Prime Vertical.*

618. *By Inspection.* See Table 29.

619. *By Computation.* Add together the log. cot. of the lat. and the log. tan. of the decl.; the sum (rejecting tens) is the log. cos. of the Hour-angle.

Ex. Lat. 31° 28′, Decl. 14° 11′ of the same name: find the Hour-angle of a celestial body on the prime vertical.

Lat.	31° 28′	cot. 0·21325
Decl.	14 11	tan. 9·40266
HOUR-ANGLE,	$4^h\ 22^m\ 26^s$	cos. 9·61591

6. *To find the Hour-angle at Rising or Setting.*

620. *By Inspection.* When the decl. is less than 24°, take out of

* This angle A is the angle at the body contained between its pol. dist. and zen. dist., or the angle P A Z, fig. p. 162.

Table 26 the *time of setting*; this is the Hour-angle required. It is called also the Semidiurnal arc.

When the decl. exceeds 24°, see No. 621, or Explan. of Table 5

621. *By Computation.* Add together the log. tangents of the lat. and decl.; the sum (rejecting tens) is the log. cos. of the Hour-angle at rising or setting, or its supplement.

When the lat. and declin. are of the *same* name, take the *supplement*; when of *contrary* names the Hour-angle is that taken out.

Ex. 1. Lat. 48° 42′ N. decl. 20° 11′ N.: find the Hour-angle at rising or setting.

Lat.	48° 42′	tan. 0·0562
Decl.	20 11	tan. 9·5654
	$4^h\ 21^m\ 4^s$	cos. 9·6216
HOUR-ANGLE,	7 38 56	

Ex. 2. Lat. 31° 10′ N. decl. 11° 14′ S.: find the Hour-angle at rising or setting.

Lat.	31° 10′	tan. 9·7816
Decl.	11 14	tan. 9·2980
HOUR-ANGLE,	$5^h\ 32^m\ 24^s$	cos. 9·0796

7. *To find the Hour-angle near the Meridian, by the observed Change of Altitude.*

622. The alts. must be on the same side of the meridian.

Correct the diff. of alts. and the interval by adding the correction in the following table:—

TIME.				ARC.					
12ᵐ	0ˢ	43ᵐ	15ˢ	1° 0′	0′ 0″	6° 15′	0′ 44″	10° 45′	3′ 51″
13	1	44	16	30	0 1	30	0 50	11 0	4 7
20	1	45	18	2 0	0 2	45	0 56	15	4 25
23	2	46	19	30	0 3	7 0	1 3	30	4 43
25	3	47	20	45	0 4	15	1 10	45	5 2
26	3	48	21	3 0	0 5	30	1 17	12 0	5 21
28	4	49	23	15	0 6	45	1 25	15	5 42
30	5	50	24	30	0 8	8 0	1 34	30	6 4
32	6	51	26	45	0 10	15	1 44	45	6 27
33	7	52	27	4 0	0 12	30	1 53	13 0	6 51
34	7	53	29	15	0 14	45	2 3	15	7 15
35	8	51	31	30	0 17	9 0	2 14	30	7 41
36	9	55	32	45	0 20	15	2 26	45	8 8
37	10	56	34	5 0	0 23	30	2 39	14 0	8 36
38	11	57	36	15	0 27	45	2 52	15	9 4
40	12	58	38	30	0 31	10 0	3 16	30	9 34
41	13	59	40	45	0 35	15	3 20	45	10 5
42	14	60	42	6 0	0 39	30	3 34	15 0	10 37

Add together the log. sin. of the diff. alts. (thus corrected), the log. cosec. of the interval (corrected), the log. sec. of the declin., the log. cos. of the mean of the two alts., and the log. sec. of the lat.: the sum (rejecting tens) is the log. sine of the hour-angle at the middle of the interval, nearly.

To find the hour-angle for the alt. *nearest* the meridian, *subtract* half the interval from this hour-angle. To find the hour-angle for the alt. *furthest* from the meridian, *add* half the interval to the hour-angle found.

Note.—If the alts. are not measured, the merid. alt., deduced from the lat. by acc. figures No. 452, may be employed, recollecting that this alt. is always somewhat *too great*, except when below the pole, when it is too small.

Ex. 1. Lat. 51° 30′ N., decl. 22° 20′ N., obtained tr. alts. 60° 27′ 52″ and 60° 34′ 35″, or diff. alts. 6′ 43″ at an interval of 4m: find the Hour-angle at the time of the alt. nearest the meridian.

D. Alt.	6′ 43″ (no corr.)	sin.	7·2909
Int.	4m (do)	cosec.	1·7581
Decl.	22° 20′	sec.	0·0339
Mean Alt.	60 31	cos.	9·6921
Lat.	51 30	sec.	0·2058
Mid. Int.	0h 21m 58s	sin.	8·9808
½ Int.	−2		
Hour-angle	19 58		

Ex. 2. Lat 40° N., decl 20° N., obtained tr. alts. 69° 58′ and 67° 0′, or diff. alt. 2° 58′, with interv. of 47m 39s: find the Hour-angle at the time of the alt. furthest from the meridian.

D. Alt.	2° 58′ 0″	Int.	47m 39s
Corr.	+5	Corr.	+21
	2 58 5		48 0
D. Alt.	2° 58′ 5″	sin.	8·7142
Int.	48m 0s	cosec.	0·6821
Decl.	20° 0′	sec.	0·0270
Mean Alt.	68 29	cos.	9·5644
Lat.	40 0	sec.	0·1157
Mid. T.	29m 10s	sin.	9·1034
½ Int.	+23 49		
Hour-angle	52 59 (only 2s too small.)		

The degree of dependence is chiefly to be estimated from the effect produced by a small change in the diff. alts.

For finding by an easy operation the apparent local time from an observed altitude, Davis's "Chronometer" Tables (J. D. Potter, London, 10*s.* 6*d*) will be found of service; they also make clear the effect and direction of any small error in the observer's latitude.

V. Times of certain Phenomena.

1. *Time of Passing the Meridian.*

[1.] *Meridian Passage of the Sun.*

623. The *Apparent Time* of the sun's meridian passage is 0h 0m 0s except below the pole, when it is 12h 0m 0s.

624. To find the *Mean Time* of the meridian passage:—

Take the Eq. of T. from page I. of the Nautical Almanac, or from Table 62; reduce it for the long. as the Green. Date. Then, if the reduced Eq. of T. is *additive* to A.T., it is the time P.M. of the sun's meridian passage. If the Eq. of T. be *subtractive* from A.T., *subtract* it from 12h: the remainder is the M.T. of passage.

Ex. 1. March 31st, 1902, long. 140° W.: find Mean Time of Sun's meridian passage.

Eq. T. 31st,	+4m 28s·3
32d,	+4 10 ·1
Daily Var.	18 ·2
Long. 9h 20m, var. 18s·2	−7 ·0
	4 28 ·3
Red. Eq. T. *add* to A.T.	4 21 ·3
M. T. of M. Pass. 12h 4m 21s 3.	

Ex. 2. Dec. 1st, 1902, long. 93° E.: find Mean Time of Sun's meridian passage.

Green. Date, Nov, 30d 17h 48m.	
Eq. T. 30th,	−11m 29s·1
31st,	−11 7 ·3
Daily Var.	21 ·8
17h 48m, var. 21s·8	−16 ·4
	11 29 ·1
Red. Eq. T.	−11 12 ·7
M.T. of Pass. 11h 48m 47s·3.	

[2.] *Meridian Passage of a Star.*

625. To find the *Apparent Time* of a star's meridian passage:—

At Sea.—See Table 27, and Explanation.

Or, from the R.A. of the star (adding 24^h if necessary) subtract the R.A. of the sun at noon, Nautical Almanac, page I., or deduced from Sidereal Time in Table 61 (*see* Note, page 211); the remainder is the A.T. required.

Ex. 1. Oct. 17, 1902: find A.T. of the Mer. Pass. of Sirius.

By Table 27.		By Sun's R.A.	
Oct. 1st,	18^h 14^m	R.A. Sirius	6^h 41^m
For 17 days	59	Oct. 17th ☉'s R.A.	13 26
Mer. Pass.	17 15 P.M.	Mer. Pass.	17 15 P.M.
Or 18th,	5 13 A.M.	Or 18th,	5 13 A.M.

Ex. 2. Find the A.T. of the Mer. Pass. of *a* Urs. Maj., above and below the Pole, on Feb. 11th, 1902. Ans. 1^h 19^m A.M.; 1^h 17^m P.M.

Ex. 3. Find A.T. of Mer. Pass. of Capella on July 20th, 1902. Ans. 9^h 11^m A.M.; 9^h 9^m P.M.

626. To find the *Mean Time* of a star's meridian passage:—

Accurately.—From the R.A. of the star (increased, if necessary, by 24^h) subtract the Sid. T. at mean noon on the day: the remainder is the approx. M.T. of transit.

Subtract from this the Retardation, Table 24.

In W. Long. *subtract* from this result the Acceleration for the Long. In E. Long. *add* the Acceleration.

The result is the M.T. of meridian passage.

Ex. 1. Jan. 1st, 1902, long. 1° 25′ W.: find M.T. of Mer. Pass. of Aldebaran.

R.A. Aldebaran		4^h	30^m	$17^s.8$
Sid. T. Mean Noon		−18	40	48·5
		9	49	29·3
Ret. 9^h	1^m $28^s.7$			
49^m	8·0		−1	36·8
29^s	·1			
1° 25′ W., or 5^m 40^s				−·9
M.T. Mer. Pass.		9	47	51·6

Ex. 2. May 22d, 1902, long. 131° 11′ E.: find M.T. of Mer. Pass. of Spica.

R.A. Spica	13^h	20^m	$4^s.6$
Sid. T. Mean Noon	3	56	42·6
	9	23	22 0
Ret. 9^h 23^m 22^s		−1	32·6
	9	21	49·4
Long. 8^h 44^m 44^s		+1	26·2
M.T. of Pass.	9	23	15 6

Ex. 3. Aug. 8th, 1902, long. 90° 15′ E.: find M.T. of Mer Pass. of Altair. Ans. 10^h 41^m $3^s.4$.

Ex 4. Feb. 1st, 1902, long. 172° 34′ W.: find M.T. of Mer. Pass. of Regulus. Ans. 13^h 16^m $5^s.0$.

Ex. 5. Oct. 1st, 1902, long. 90° 48′ E.: find M.T. Mer. Pass. of Markab. Ans. 10^h 22^m $6^s.1$.

[3.] *Meridian Passage of the Moon.*

627. This is required only approximately.

In W. Long. take from the Naut. Almanac the diff. between the Mer. Pass. of the proposed day and the next (given in *mean time* to 0^m 1). In E. Long. take the diff. between that for the proposed day and the day before. The diff. is the daily variation.

Take from Table 28 the correction corresponding to the daily variation and longitude. In W. Long. add this corr. to the time of mer. pass. on the given day; in E. Long. subtract it; the result is the time required.

When one mer. pass. has 23ʰ, and the next 0ʰ, 24ʰ must be added to the latter in finding the Daily Variation.

Ex. 1. Find Mer. Pass. of ☾ Jan. 16th, 1878, long. 46° W.

Mer. Pass. 16th,	10ʰ 9ᵐ 1
17th,	11 11 ·6
Daily Var.	1 2 ·5
46° W. var. 62ᵐ·5	+7 ·6
	10 9 ·1
Mer. Pass.	10 16 ·7

Jan. 16th, at 10ʰ 16ᵐ·7 P.M.

Ex. 2. July 24th, 1878, long. 130° E.: find the Mer. Pass. of the Moon.

Mer. Pass.	23ᵈ 19ʰ 1ᵐ·8
	22 18 14 ·1
Daily Var.	47 ·7
130° E. var. 47ᵐ·7	−16 ·8
	23 19 1 ·8
Mer. Pass.	23 18 45 ·0

July 24th, at 6ʰ 45ᵐ A.M.

628. As the lunar day, or the interval between the moon's mer. pass. and her return to the same meridian again, exceeds 24 hours or a mean solar day, an entire day passes at certain intervals without a lunar transit. For ex.:—

The moon passes the meridian on the 3d, at 23ʰ 50ᵐ, or 10ᵐ before the noon concluding the 3d. The lunar day being, at least, 40ᵐ longer than the mean solar day, the moon will not have reached the merid. by about 30ᵐ at next noon, or that concluding the 4th; she accordingly passes the merid. about 0ʰ 30ᵐ on the 5th, having skipped the 4th altogether

There may thus be no mer. pass. on the day proposed.*

Ex. 1. March 3rd, 1878, long. 21° W.: find the Moon's Mer. Pass.

Mer. Pass.	2ᵈ 23ʰ 44ᵐ·1
	3 * *
	4 0 23 ·5
Daily Var.	39 ·4
Long. 21° W. var. 39ᵐ·4	+2 ·0
	2 23 44 ·1
Mer. Pass.	2 23 46 ·1

March 3rd at 11ʰ 46ᵐ·1 A.M.

Ex. 2. October 26th, 1878, long. 38° E.: find the Moon's Mer. Pass.

Mer. Pass.	26ᵈ 0ʰ 7ᵐ·7
	25 * *
	24 23 10 ·2
Daily Var.	57 5
Long. 38° E., var. 57ᵐ·5	5 ·7
	26 0 7 ·7
Mer. Pass.	26 0 2 ·0

October 26th, at 0ʰ 2ᵐ P.M.

In W. Long., when the sum of the corr. and mer. pass. exceeds 24ʰ, subtract 24ʰ, and reckon the time on the next day. In E. long., when the corr. exceeds the time of mer. pass., add 24ʰ to the latter, and reckon the time on the day before.

Ex. 1. Suppose Ex. 1 above, the long. to be 170° W.

Long. 170° W. var. 39ᵐ·4	+18ᵐ·0
	2ᵈ 23 44 ·1
Mer. Pass.	3 0 2 ·1

March 3rd, at 0ʰ 2ᵐ·1 P.M.

Ex. 2. Suppose Ex. 2 above, the long to be 90° E.

Long. 90° E., var. 57ᵐ·5	−13ᵐ·7
	26ᵈ 0ʰ 7 ·7
Mer. Pass.	25 23 54

October 26th, at 11ʰ 54ᵐ A.M.

* This occurs about the time of conjunction with the sun, and the day skipped is marked ☌ in the Nautical Almanac. In like manner a day is skipped at the *lower* transit (under the pole) at opposition.

[4.] *Meridian Passage of a Planet.*

629. The meridian passages of the planets, like those of the moon, are given in the Nautical Almanac to $0^{m}\cdot1$ of mean time.

A planet, of which the R.A. increases faster than that of the sun, skips a day at conjunction, as observed in No. 628 of the moon. On the other hand, when the R.A. diminishes, or the motion of the planet among the stars is reversed, two transits occur within the limits of the mean solar day.

As the greatest daily variation of meridian passage of Venus amounts to 6^{m} only, the mer. passages of the planets may be taken at once from the Nautical Almanac for all practical purposes.

2. *Time of Passage of the Prime Vertical.*

[1.] *Of the Sun.*

630. *Approximately.* Find the Hour-angle by Table 29: this is the App. Time, approximately, of the afternoon passage; the supplement to 12^{h} is the Approx. Appar. Time of the forenoon passage.

Ex. 1. Jan. 20th, 1878, lat. 39° S.: find the times of the Sun's Passage of the Prime Vertical.

Jan. 20th, Sun's Decl. 20° 5′ S., Table 29, lat. 39° and decl. 20°, give Hour-angle $4^{h}\ 13^{m}$. The A T. of the W. transit is $4^{h}\ 13^{m}$ P.M., that of the E. is $12^{h} - 4^{h}\ 13^{m}$, or $7^{h}\ 47^{m}$ A.M.

Ex. 2. June 20th, 1878, lat. 55° N.: find the A.M. and P.M. transits of the Prime Vertical.

Lat. 55° decl. 23° 27′ N., or 23½°, Hour-angle $4^{h}\ 52^{m}$, which is P.M. transit: the other passage is at $7^{h}\ 8^{m}$ A.M.

631. *Accurately.* Having found the Approx. App. Time as above (No. 630), apply to it the long. in time; this gives the Green. Date in App. Time

To this reduce the sun's declination, and compute the hour-angle by No. 619.

Ex. 1. Aug. 29th, 1878, required the App. Time of Passage P.M. at Tenby, in lat. 51° 40 20″ N., long. 4° 41′ W.

Lat. 51½° decl. 9½° Table 29 gives	$5^{h}\ 30^{m}$	
4° 41′ W.	+ 19	
Green. Date, 29th,	5 49	
Decl. 29th,	9° 19 33″·8 N.	
30th,	8 58 6 ·1 N.	
	21 27 ·7	0485
	5 49	6155
	5 12	6640
	9 19 33 ·8	
Red. Decl	**9 14 21 ·8 N.**	

		Parts for′
51° 40′ 20″ cot.	9·898010	− 86
9 14 22 tan.	9·211018	+ 295
	9·109028	
	+ 209	
Cos.	9·109237	

PASS. P. VERTICAL, $5^{h}\ 30^{m}\ 27^{s}$

Ex. 2. May 13th, 1878, find the Time of Passage A.M. at South Shields, lat. 55° 0′ 50″ N., long. 1° 25′ W.

Green. Date, May $12^{d}\ 19^{h}\ 0^{m}$

Red. Declin. 18° 22′ 16″ N.

APP. TIME PASS. $6^{h}\ 53^{m}\ 45^{s}$ A.M.

[2.] *Of a Star.*

632. Find the A.T. of meridian passage. When the time of the *east* transit is required, *subtract* the Hour-angle (Table 29) from

this A.T. (increased if necessary by 24^h); for the time of *west.* transit, *add* the Hour-angle.

Ex. 1. Find the Times of Eastern and Western Transits of Prime Vertical of Aldebaran at So. Shields, on Jan. 1st, 1878.

App. Time Mer. Pass. Tab. 27	$9^h\ 41^m$		$9^h\ 41^m$
Decl. 16° lat. 55°	$-5\ \ 14$		$5\ \ 14$
App. Time of. E. Transit,	4 27 P.M.		14 55
		W. Transit of 2d,	2 55 A.M.

Ex. 2. July 11th, 1878, lat. 51° 30′ N.: find Times of E. and W. Transits of Prime Vertical of α Lyræ. *Ans.* App. T. of Pass. E. $7^h\ 50^m$ P.M.; W. $2^h\ 30^m$ A.M.

Ex. 3. Dec. 4th, 1878, lat. 40° 10′ S: find Times of E. and W. Transits of Prime Vertical of Antares. *Ans.* App. T. of Pass. E $8^h 1^m$ A.M.; W. $3^h\ 17^m$ P.M.

Ex. 4. Aug. 17th, 1878 lat. 56° 3′ N.: find Time of E. Transit of Prime Vertical of Altair. *Ans.* App. T. of Pass. E. $4^h\ 22^m$ P.M.

[3.] *Of the Moon.*

633. *Approximately.* Proceed as for a star, using M.T. for A.T., because the time of her mer. pass. is given in M.T.

634. *More Accurately.* Find the approximate time as for a star; find the Green. Date, and reduce to it the declination. Find the Hour-angle by No. 619. This Hour-angle, with the correct time of mer. passage, gives the time more nearly. Correct the declination and repeat the computation. For extreme precision, a correction would be required for the oblateness of the earth.

[4.] *Of a Planet.*

635. Find the M.T. of the Meridian Passage of the planet, in the Nautical Almanac, and apply the Hour-angle as directed for a star; the result is in M.T.

Ex. 1. Jan. 19th, 1878, lat. 54° 33′ S.: find the time of W. Transit of Prime Vertical of Venus.

M.T. Mer. Pass, 19th page 274 N.A.	$2^h\ 39^m$
Lat 54° S., Decl 6° S.	$+5\ \ 42$
M.T. of Pass.	8 21 P.M.

Ex. 2. Aug. 9th, 1878, lat. 49° 56′ S.: find the Time of E. Transit of Prime Vertical of Jupiter.

M.T. Mer. Pass. 9th page 254 N.A.	$10^h\ 57^m$
Lat. 50° S., Decl 21° S.	$-4\ \ 10$
M.T. of Pass.	6 47 P.M.

3 *Times of Rising and Setting.*

These are required approximately only.

[1.] *Of the Sun.*

636. See Table 26, and Explanation.

[2.] *Of a Star, the Moon, or a Planet.*

637. Find the A.T. (or M.T., according as required) of the meridian passage, No. 625, &c. Find the Hour-angle at rising or setting, No. 620.

To find the time of *rising, subtract* this Hour-angle from the time of mer. passage (increased if necessary by 24^h); to find the Time of *setting, add* them together, rejecting 24^h if the sum exceed 24^h.

Ex. Jan. 1st, 1878, lat. 50° N.: find A.T. of rising and setting of Aldebaran.

A.T. Mer. Pass., Table 27	$9^h\ 41^m$	A.T. Mer. Pass.	$9^h\ 41^m$
55° N., Decl. 16° N.	−7 37		7 37
A.T. of Rising	2 4 P.M.	A.T. of Setting	17 18
		Or at $5^h\ 18^m$ A.M. on 2d.	

638. To find the change in the time of apparent rising or setting due to the horizontal refraction and the height of the spectator, No. 446 (1) and (2).

By Computation. Add together the log. secants of the latitude and declination, the log. cosec. of the hour-angle at rising or setting, and the log. sine of 34′+depr. for the height of the eye, Table 8; the sum is the log. sine of the portion of time required, nearly.

Ex. 1. Find the difference of times of Sunset to an eye at the level of the sea, and on the summit of the Peak of Teneriffe, on May 4th.

Hour-angle at setting (No. 621), $6^h\ 35^m\ 52^s$.

Lat.	28° 16′	sec.	0·0551
Decl.	16 10	sec.	0·0175
H.-Ang.	$6^h\ 36^m$	cosec.	0·0054
34′ + 117′ = 2° 31′		sin.	8·6426
Time req.	$12^m\ 3^s$	sin.	8·7206

Ex. 2. Lat. 28° 16′ N., declin. 16° 10′ N.: required the difference in the times of Sunset to the eye at the level of the sea, and elevated 16 feet above it.

Hour-angle at level of the sea, $6^h\ 35^m\ 52^s$.

Lat.	sec.	0·0551
Decl.	sec.	0·0175
Hour-angle	cosec.	0·0054
34′ + 4′,	sin.	8·0435
Time req. $3^m\ 2^s$	sin.	8·1215

This process is very nearly correct in low latitudes, but in high latitudes, where the body, instead of rapidly passing the horizon, partly skims along it, the result, when the dip is large, is too small.

Thus, for the above depression, 117′, in lat. 50° (and declination above), the time comes out $17^m\ 23^s$, it should be $17^m\ 38^s$; and in lat. 60°, the result, $24^m\ 17^s$, should be $25^m\ 4^s$.

639. More accurately, find the Hour-angle of the given celestial body when below the horizon 34′+depression due to the observer's height, by No. 642; this is effected by using 34′+depr., instead of 18°. The Diff. between this Hour-angle and that found by No. 621 is the portion of time required.*

640. Since the moon's parallax exceeds the refraction, Nos. 433 and 436, she always appears below her true place, and therefore rises later, and sets earlier, than a more distant body of the same declination. Accordingly, in the preceding rule we must use, instead of 34′, the diff. between the hor. par. and 34′, and the difference instead of the sum of the latter and the depression. If the depression is the greater, the rising is accelerated, otherwise retarded. For the hor. par. 61′, these effects neutralise each other at the height of 650 feet; for 53′, at 320 feet; that is, to the eye placed at these heights the moon in these cases rises and sets nearly at her true time.

* In strictness, however, some correction (subtractive) is due to the refraction itself when the body is seen at a considerable depression.

4. *Times of the Beginning and End of Twilight.*

641. *By Inspection.* See Explanation of Table 5.

642. *By Computation.* Add together 18°, the lat., and the pol. dist., take half the sum, and from it subtract 18°, or the upper term. Add together the log. sec. of the lat., the log. cosec. of the pol. dist., the log. sine of the half sum, and the log. cos. of the remainder; the sum (rejecting tens) is the log. sine square of the sun's hour-angle when 18° below the horizon.

This Hour-angle is the App. time of the *end* of twilight, P.M.; and the *supplement* to 12^h is the App. time of the *beginning*, A.M.

NOTE.—The declination at noon, and 4, or even 3, places in the logs. are enough for this purpose.

Ex. 1. April 22d, 1878, lat. 51° 46′ N.: find the Beginning and End of Twilight.

Const.	18° 0		
Lat.	51 46	sec.	0·2084
P D.	77 45	cosec.	0·0100
	147 31		
	73 45	sine	9·9823
	55 45	cosine	9·7504
END	9^h 28^m	sine sq.	9·9511
BEG.	2 32		

Ex. 2. Dec. 21st, 1878, lat. 55° 1′ N.: find the Beginning and End of Twilight.

Const.	18° 0′		
Lat.	55 1	sec.	0·2416
P.D.	113 27	cosec.	0·0374
	186 28		
	93 14	sine	9·9993
	75 14	cosine	9·4063
END	5^h 52^m	sine sq.	9 6846
BEG.	6 8		

Ex. 3. March 3d, 1878, lat. 60° 47′ S. Twilight begins 2^h 8^m A.M., ends 9^h 52^m P.M.

Ex. 4. Jan. 2d, 1878, lat. 70° 1′ N., Twilight begins, 6^h 42^m A.M., ends 5^h 18^m P.M., the sun not appearing above the horizon.

643. The *duration* of twilight, or the interval between the beginning of twilight and the sun's rising, or between sunset and darkness, is found by taking the differences of these times. Thus, in Ex. 1, it is 9^h 28^m − 7^h 3^m (setting, Table 26), or 4^h 57^m (rising) − 2^h 32^m, which is 2^h 25^m. In Ex. 2, it is 5^h 52^m − 3^h 27^m, or 2^h 25^m.

The shortest duration is at the equator, when the sun moves through 18° in 1^h 12^m; at the poles it continues several months.

When the lat. (of the same name with the decl.) exceeds the compl. of 18° + decl., the sun is less than 18° below the horizon at midnight, or twilight lasts all night, as for ex. with lat. 58° N., decl. 21° N.

VI. ALTITUDES.

1. *Correction of the Observed Altitudes.*

644. The corrections necessary to reduce an altitude observed from the sea-horizon with a sextant or circle to the *true* altitude, consists of the Index Correction, the Dip, the Correction of Altitude (or the joint effect of refraction and parallax, No. 438,) and, in certain cases, the Semidiameter.

When one of the instruments, No. 522 or 523 is used, the Dip is omitted; the constant correction should be applied the first thing.

645. The *apparent* alt. is deduced from the *observed* alt. by applying all the above corrections except refraction and parallax.

646. When the altitude is less than 10°, the mean refraction in Table 31 may be in error more than 1′, and should be corrected by Tables 32 and 33 if a barometer and thermometer are at hand. For precision, this is necessary in all cases.

[1.] *To Correct the Sun's Altitude.*

647. *At Sea.* Apply the Ind. Corr.; subtract the dip corresponding to the height of the eye, Table 30; subtract the refraction for this alt., Table 31, to the nearest minute.

When the *lower* limb is observed, *add* 16′ to this reduced alt.; when the *upper* limb is observed, *subtract* 16′; the result is the true or corrected alt. of the sun's centre.

Ex. 1. Obs. alt. of ⨀ 28° 54′, ind. corr. +3′, height of the eye 16 feet: required True Alt. of the centre.

Obs. Alt.	28 54′
Ind. Corr.	+ 3
	28 57
Dip	− 4
	28 53
Refr. (for 29°)	− 2
	28 51
Semid. (*low. l.*)	+ 16
TRUE ALT.	29 7

Ex. 2. Obs. alt. of ⨀̄ 42° 11′, ind. corr. −17′, height of the eye 30 feet: required True Alt. of the centre.

Obs. Alt.	42° 11′
Ind. Corr.	− 17
	41 54
Dip	− 5
	41 49
Refr. (for 42°)	− 1
	41 48
Semid. (*upper l.*)	− 16
TRUE ALT.	41 32

Ex. 3. Obs. alt. ⨀ 10° 4′, ind. corr. + 2′, height of eye 18 feet: required the True Alt. of Sun's centre. TRUE ALT. 10° 13

Ex. 4. Obs. alt. ⨀̄ 42° 11′, ind. corr. −17′, height of eye 30 feet: required the True Alt. of the centre. TRUE ALT. 41° 32′.

648. In the open sea, where an error of 2′ or 3′ of lat., and a corresponding error of long., are of no great consequence, the corr. of alt. for the sun (when the *lower* limb is observed), may be taken from Table 38, in which it is given to the nearest minute.

Ex. 1. (Ex. 1 above.)

Obs. Alt. ⨀	28 54
Ind. Corr.	+ 3
	28 57
Ht. 16 f., Alt. 29° Corr.	+ 11
TRUE ALT.	29 8

Ex. 2. (Ex. 3 above.)

Obs. Alt. ⨀	10° 4
Ind. Corr.	+ 2
	10 6
Ht. 18 f., Alt. 10°, Corr.	+ 7
TRUE ALT.	10 13

If the upper limb has been observed, proceed as above, and deduct 32′.

Ex. Obs. Alt. ⨀̄ 88° 40′, Ht. of Eye 30 f., Ind. Corr. − 5, TRUE ALT. 88° 14′.

649. *Accurately.* Apply the ind. corr. and (at sea) the dip; correct the refr. by Tables 32, 33; take the semid. and parallax from the Nautical Almanac; and subtract the parallax in alt., Table 34.

Minute accuracy in alt. at sea can rarely be worth the trouble bestowed upon it, from the uncertain state of the sea-horizon. The examples, No. 651, will serve, supplying the dip.

650. When the altitude of either limb of the sun is observed, and the altitude of the other limb (which will appear the same in the instrument) is observed from the opposite point of the horizon (No. 535), take half the diff. of these angles and *add* to it the correction of alt.; the sum is the true zen. dist.

Ex. 1. Obs. Alt. ⊙ S. 63° 49′ 20″, ⊙ N. 115° 46′ 20″: required the true Zenith Distance.

⊙ N.	115° 46′ 20″
S.	63 49 20
	2) 51 57 0
App. Zen. Dist.	25 58 30
Refr.	+ 29
TRUE Z. DIST.	25 58 59 N.

Ex. 2. Obs. Alt. ⊙ N. 81° 59′ 0″, ⊙ S. 97° 40′ 30″: required the true Zenith Distance.

⊙ S.	97° 40′ 30″
N.	81 59 0
	2) 15 41 30
App. Zen. Dist.	7 50 45
Refr.	+ 8
TRUE Z. DIST.	7 50 53 S.

651. *On Shore.* When the alt. is observed from the quicksilver, apply the ind. corr. at once; halve the result, and proceed as in No. 649, omitting the dip.

Ex. 1. Jan. 1st, 1878, alt. ⊙ in the quicksilver 17° 24′ 0″, ind. corr. − 4′ 50″, bar. 30·6 inch, therm. 44°: find the True Alt.

		Obs. Alt. ⊙	17° 24′ 0″
		Ind. Corr.	− 4 50
M. Refr.	6′ 6″		2) 17 19 10
Therm.	+ 5		8 39 35
Bar.	+ 7		
	6 18	Corr. of Alt.	− 6 9
Par.	− 9		
Corr. of Alt.	6 9		8 33 26
		Semid.	+ 16 18
		TRUE ALT.	8 49 44

Ex. 2. July 1st, 1878, alt. ⊙ 60° 11′ 40″. ind. corr. + 2′ 35″, bar. 29·2, therm. 76°: find the True Alt.

		Obs. Alt. ⊙	60° 11′ 40″
		Ind. Corr.	+ 2 35
M. Refr.	1′ 41″		2) 60 14 15
Therm.	− 5		30 7 7
Bar.	− 3		
	1 33		
Par.	− 7		
Corr. of Alt.	1 26	Corr. of Alt.	− 1 26
		Semid.	− 15 46
		TRUE ALT.	29 49 55

Ex. 3. May 3d, 1878, obs. alt. ⊙ in the quicksilver 116° 14′ 0″, ind. corr. + 2′ 0″, bar. 29·2, therm. 58°: required the True Altitude. TRUE ALT. 58° 23′ 23″.

Ex. 4. July 9th, 1878, obs. alt. ⊙ in the quicksilver 120° 17′ 50″, ind. cor. + 54″, bar. 29·8, therm. 62°: required the True Altitude. TRUE ALT. 60° 24′ 39″.

[2.] *To Correct a Star or a Planet's Altitude.*

652. *At Sea.* Apply the index corr.; subtract the dip and refraction.

Ex. 1. Obs. alt. of a star 10° 28′, ind. corr. + 2′, height of eye 16 feet: required the True Alt.

	10° 28′
	+ 2
	10 30
Dip 4 and Refr. 5′	− 9
TRUE ALT.	10 21

Ex. 2. Obs. alt. of a star 46° 12′, ind. corr. − 3′, height of eye 16 feet: required the True Alt.

	46° 12
Sub. 3′, 4′, and 1′	8
TRUE ALT.	46 4

Or, having corrected for index error, subtract the corr. in Table 38.

Ex. 3. Obs. alt. of the planet Venus 30° 14′, ind. corr. + 3′, height of eye 12 feet: required the True Alt.

Obs. Alt.		30° 14′
Ind. Corr.	+ 3′	−2
Table 38,	− 5	
TRUE ALT.		30 12

Ex. 4. Obs. alt. of the planet Mars 78° 57′, ind. corr. + 7, height of eye 30 feet: required the True Alt.

Obs. Alt.		78° 57
Ind. Corr.	+ 7′	+ 2
Table 38,	− 5	
TRUE ALT.		78 59

653. *Accurately*. Proceed as for the sun, No. 649, omitting semidiameter.

A star's corr. of alt. is the refraction alone, No. 438, p. 147.

For a planet, find the hor. par. in the Nautical Almanac; find the par. in alt. corresponding, in Table 45, and deduct it from the refraction.

Ex. 1. Obs. Alt. of Sirius in the quicksilver 37° 9′ 35″, ind. corr. −7′ 30″, bar. 30·2, therm. 42° : required the True Alt.

✱ Obs. Alt.		37° 9′ 35″
Ind. Corr.		−7 30
		2) 37 2 5
		18 31 2
M. Refr.	2′ 53″	
Therm.	+ 3	−2 57
Bar.	+ 1	
Corr.	−2 57	
TRUE ALT.		18 28 5

Ex. 2. Obs alt. of α Polaris in the mercury 102° 38′ 30″, ind. corr. + 1′ 30″, therm. 62°, bar. 30 inch.

✱ Obs. Alt.		102° 38′ 30″
Ind. Corr.		+ 1 30
		2) 102 40 0
		51 20 0
M. Refr.	0′ 46″·8	
Therm.	− 1 ·2	−0 46
Corr.	0 45 ·6	
TRUE ALT.		51 19 14

Ex. 3. Dec. 21st, 1878, obs. alt. Venus in the quicksilver 116° 48′ 40″, ind. corr. + 1′ 40″, bar. 29·8, therm. 62°: required the True Alt.

Venus' H.P., p. 277, N.A. 5″·2

Obs. Alt.		116° 48′ 40″
Ind. Corr.		+ 1 40
		2) 116 15 20
		58 25 10
M. Refr.	0′ 35″·9	
Therm.	−0 ·9	
Bar.	−0 ·2	
	0 34 8	−0 32
Par.	−2 ·6	
Corr. of Alt.	0 32 ·2	
TRUE ALT.		58 24 38

Ex. 4. Feb. 6th, 1878, obs. alt Mars in the quicksilver, 41° 49′ 30″, ind. corr. + 1′ 20″, bar. 29·2, therm. 58 : required the True Alt.

Mars' H.P., p. 278, N.A. 5″·5

Obs. Alt.		41° 49′ 30″
Ind. Corr.		+ 1 20
		2) 41 50 50
		20 55 25
M. Refr.	2′ 31″·8	
Therm.	− 3	
Bar.	− 4	
	2 24 ·8	− 2 20
Par.	− 5 ·1	
Corr. of Alt.	2 19 ·7	
TRUE ALT.		20 53 5

[3.] *To Correct the Moon's Altitude.*

654. *At Sea.* Find the Green. Date roughly, and take out of the Nautical Almanac the hor. par. and semid. to the nearest noon or midnight.

Apply the ind. corr. to the alt., subtract the dip; when the *lower* limb is observed, *add* the semid.; when the *upper* limb is observed, *subtract* it; the result is the *app. alt.* of the centre.

With the A. alt. and hor. par. find, in Table 39, the moon's corr. of alt., which *add*. The result is the true or corrected alt. of the moon's centre, approximately.

Ex. 1.* May 13th, 1878, long. 52° W., at $8^h\ 42^m$ P.M., obs. alt., ☽ 37° 10′, ind. corr. + 3′, height of eye 14 feet: required the True Alt.

The Gr. Date is 13th, $12^h\ 10^m$, H.P. at midnight 60′, semid. 16′.

		☽	37° 10′
Ind. Corr.	+ 3′		
Dip	− 4		+ 15
Semid.	+ 16		
			37 25
37° 25′, H.P. 60′			+ 46
True Alt.			38 11

Ex. 2. Sept. 18th, 1878, long. 160° E., at 2^h A.M., obs alt. ☽ 61° 20′, height of eye 16 feet, ind. corr. − 3′: find the True Alt.

The Gr. Date 17th, $3^h\ 20^m$, H.P. at noon, 55. semid. 15′.

		☽	61° 20′
Ind. Corr.	− 3′		
Dip	− 4		− 22
Semid	− 15		
			60 58
61° 0′, H.P. 55′			+ 26
True Alt.			61 24

Ex. 3. Jan. 3d, 1878, long. 159° E., at $9^h\ 10^m$ P.M ☽ 85° 42′, height of eye 20 feet, Ind. corr. + 3′ True Alt. 86 1′.

Ex. 4. July 5th, 1878, long. 172° W., at 3^h A.M., ☽ 14° 28′, ind. corr. 0′, height of eye 18 feet. True Alt. 15° 1′.

655. *Accurately.* (1.) Reduce the hor. par. to the Gr. Date, and find the semid. Table 40. Reduce the par. by Table 41, and augment the semid. Table 42.

(2.) Take out the refraction for the limb observed, correct it for barom. and therm.; subtract this corrected refraction from the alt. and apply the augmented semidiameter.

(3.) To the log. sec. of the alt. thus reduced add the prop. log. of the reduced hor. parallax; the sum is the prop. log. of the parallax in alt. This par. added to the reduced alt. gives the true alt. of the centre.

As, however, the degree of precision obtained by these precepts will rarely be required, we shall, in the following example, employ Table 39.

Ex. 1. July 30th, 1878, lat. 42° S, long. 42° 13′ W., at $5^h\ 24^m\ 38^s$ M.T. obs alt. ☽ 36° 39′ 50″, ind. corr. + 2′ 17″, height of eye 22 feet; therm. 72°, bar. 29·1: required the True Alt.

The Gr. Date, 30th, $8^h\ 13^m\ 30^s$	
H.P. 30th, Noon	59′ 55″ 6
30th, Midn.	60 6 ·2
12-hourly Var.	+ 10 ·6
$8^h\ 14^m$, var. 10″·6	+ 7 ·2
	59 55 6
Equat. H P.	60 3 ·8
Red. for Lat.	− 5 ·2
Red. H P.	59 57 6
Semid. corresp. to 59′ 58′	16′ 21
Augment.	10
Aug. Semid.	16 31

Obs. Alt.			36° 39′ 50″
Ind. Corr.	+ 2′ 17″		
Dip.	− 4 30		− 2 13
			36 37 37
Aug. Semid.			+ 16 31
			36 54 8
36° 50′ and 59′		45 56″	
4		− 2	
	58″	+ 47	
		46 41	
Therm. 72°, *sub.* 3″			
Bar. 29·1 *sub.* 2		+ 5	
		46 46	+ 46 46
True Alt.			37 40 54

656. When the moon is referred to the opposite point of the horizon, No. 535, half the diff. of the alt. and its supplement is the zenith distance of the illuminated limb, to which the augmented

* The examples being given merely in illustration of the rules, no regard has been paid to the visibility of the moon at the time and place specified.

semid. is to be applied the contrary way to that directed for the alt. In certain cases both limbs can thus be observed, No. 540, and the semidiameter avoided.

2. *To Reduce the True to the Apparent Altitude.*

[1.] *For the Sun, a Star, or a Planet.*

657. Take out the refraction to the true alt. as if for the app. alt., correcting it, when necessary, for the barom. and therm.; *subtract* the parallax in alt., add the remainder to the true alt., and subtract the correction in Table 43.

[2.] *For the Moon.*

658. Find her corr. of alt. for the true alt., as if for the app. alt., and apply the corr., Table 44.

Ex.	☽'s Hor. Par. 59′, True Alt.	48° 41′ 12″
	48° 41′, and 59′, − 38′ 6″; Corr. Table 44, − 28	− 38 34
	App. Alt.	48 2 38

659. To reduce the app. alt. to the observed alt. for a particular instrument and given height of the eye, apply the ind. corr. the *opposite* way, and *add* the dip.

3. *Reduction of Two Altitudes to an Intermediate Point of Time.*

660. Two altitudes observed at periods of time not distant, afford, by simple proportion, the altitude at an intermediate time.

(1.) Find the interval between the time of the 1st alt. and the time proposed, and call it the partial interval.

(2.) To the prop. log. of the partial interval add the ar. co. prop. log. of the whole interval, and the prop. log. of the diff. of alts.; the sum is the prop. log. of the change of alt. in the partial interval.

(3.) When the 1st alt. is the *lesser*, *add* this change; when it is the *greater*, *subtract* the change.

Ex 1. At $10^h\ 18^m\ 4^s$ by watch, obs. an alt. 54° 56′; at $10^h\ 29^m\ 11^s$ obs. a second alt. 55° 12′: required the Alt. at $10^h\ 23^m\ 6^s$.

Alt.	54° 56′	time $10^h\ 18^m\ 4^s$			
		10 23 6	$5^m\ 2^s$	pr. log.	1·553
	55 12	10 29 11	11 7	ar. co. p. log.	8·791
Diff.	16	....		pr. log.	1·051
		Change of Alt.	7′	pr. log.	1·395
			54 56		
		Alt. req.	55 3		

Ex. 2. At $12^h\ 5^m\ 24^s$ by watch, obs. an alt. 39° 2′; and at $1^h\ 8^m\ 18^s$ obs. a second alt 36° 42: required the Alt. at $1^h\ 1^m\ 29^s$. Change of Alt. −0° 53′, and Alt. req. 38° 9′.

Ex. 3. At $0^h\ 58^m\ 36^s$ by watch, obs. an alt. 47° 33′, and at $1^h\ 5^m\ 47^s$, obs. a second alt. 47° 52′: required the Alt. at $1^h\ 1^m\ 29^s$. Change of Alt. + 8′, and Alt. req. 47° 41′.

The altitude thus deduced differs from the true alt. by a proportional part of the 2d diff. of alt. upon the interval, No. 558. The method serves very well when the azimuth is large, or the object 60° or more from the meridian, or less if the interval be small; but in cases near the meridian the result will be sensibly in error, unless the interval is very small. The error arising from the neglect of the 2d diff. will be less as the intermediate time is nearer to the beginning or end of the interval.

4. *Reduction of an Altitude to another Place of Observation.*

661. The run of the ship in the interval between the taking of the two altitudes which constitute certain observations, renders it necessary to reduce one to the place of the other.

When the ship approaches the sun directly she raises him 1′ for each mile of distance made good. When the sun bears obliquely (as for ex. 3 points) from the course made good, if we consider the angle between this last course and the sun's bearing (or 3 points) as a course, the space by which the ship approaches the sun is the D. Lat. corresponding to her Dist. made good.*

When the sun's bearing is at right angles to the course made good, the ship neither approaches nor recedes from him; when the bearing is abaft this line, she drops the sun.

When it is required to reduce an alt. observed at 1 o'clock (for ex.) to what it would have been if observed at the place where the ship is at 2 o'clock, the ship having approached the sun, we have merely to add to the alt. observed at 1 o'clock the portion of space or arc by which the ship would have raised the sun in 1^h, if he had preserved his bearing at 1 o'clock unaltered. Hence the following rules.

To reduce the 1st alt. to the second place of observation.

(1.) Take the diff. between the bearing of the body at the first observation and the ship's course, as a Course, and the dist. run as a Distance; the D. Lat. corresponding is the reduction for run.

(2.) When this course is *less* than 90° or 8 points, *add* the red. to the first alt.; when the said course exceeds 90° or 8 points, *subtract* the red.; the result is the alt. reduced to what it would have been if observed at the second place of the spectator.

If the ship does not preserve the same course, the course made good must be employed.

As it is *difference* only of bearing or azimuth that enters into this question, the variation (supposed the same at both observations) is not considered; but if the ship's course changes, the deviation should be attended to.

Ex. 1. Observed the sun's alt., the sun bearing S.E. by E. ¼ E. the course E. by N. ½ N. (by compass). Sailed for 1^h 15^m at the rate of 7½ knots: required the Reduction of the Alt. for Run.

From S.E. by E. ¼ E. to E. is 2¾ pts.; from E. to E. by N. ½ N. is 1½ pts. The course 4¼ points, and dist. 9·4, give D. Lat. 6′·3 the REDUCTION to be *added* to the Alt.

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* As the distance is described upon a spherical surface, in strictness a correction is necessary; also the dist. made good on the spiral rhumb should be reduced to that on a great circle; but these refinements are generally inconsistent with the rude *data* of the question.

Ex. 2. Sun South, alt. 55° 30′·5, course E. by N., rate 6·8 knots, interval 12ᵐ: reduce the Alt. for the Run.
The suppl. of 9 pts., or 7 pts., and dist. 1·4, give D. Lat. 0·27, or 0′·3, which *subtracted* from 55° 30′·5, gives 55° 30′·2, the ALT. required.

Ex. 3. Obs. sun's alt., sun bearing N.E. ½ E., course N.W. ¼ N., sailed for 36ᵐ 10ˢ at the rate of 10·2 knots: required the Reduction for Run. The REDUCTION is 0′·0.

Ex. 4. Obs. a star's alt. 37° 18′ 40″, bearing S.E. by E. ½ E., course N.W. by W. ¼ W., rate 5·8 knots, interval 2ʰ 24ᵐ: reduce the Alt. for Run.
The REDUCTION is 13′·9 to *sub.*; the ALT. 37° 4′·8.

When the course at the 1st observation is *directly towards* the sun, the dist. run in the interval is the correction, and is to be *added* to the 1st alt.; when *directly from* the sun, to be subtracted.

Ex. Obs. sun's alt. 29° 7′ 30″, bearing E.S.E., course E.S.E., rate 5·4 knots, interval 3ʰ 6ᵐ; reduce the Alt. for Run.
The REDUCTION is 16′·7 to *add*; the ALT. 29° 24′·2.

662. To reduce the 2d alt. to the first place of observation.

Take the bearing at the last observation; find the reduction of the alt. as above, and apply it to the 2d alt. the contrary way to that directed in (2) above.

Ex. 1. Observed the sun's alt., sailed S.S.W. for 48ᵐ at the rate of 3½ knots, when the 2d alt. was taken, the sun bearing W.S.W.: required the Correction of the Alt. for Run.
From S.S.W. to W.S.W. is 4 pts. The course 4 pts., and Dist. 2·8, give the D. Lat. 2·0 to be *subtracted* from the 2d Alt.

Ex. 2. Course N.W. by N., observed the sun's alt. After sailing for 1ʰ 36ᵐ at 8·2 knots, observed the 2d alt. 39 44′, the sun bearing E S E.
From N.W. by N. to E.S.E. is 13 pts.; then the course 3 pts., and Dist. 13·1, give D. Lat. 10·9, which *added* to 39° 44′ gives 39° 54′·9, the Alt. reduced.

When the course at the 2d observation is *directly towards* the sun, the dist. run is the correction, and is to be *subtracted* from the second alt.; when *directly from* the sun, it is to be *added*.

5. *To find the Altitude.*

[1.] *On the Meridian.*

663. For the sun, the moon, or a planet, find the time of Mer. Pass., No. 623, &c., and reduce the declin., No. 579, &c. Find the colat. When the lat. and decl. are of the same name take the sum of the colat. and decl.; when of different names, their diff.; the result is the mer. alt. If the sum exceeds 90° take its complement.

Below the Pole. Find the pol. dist., and subtract it from the latitude.

[2.] *On the Prime Vertical.*

664. *By Inspection.* See Table 29, and Explan. of Table 5.

665. *By Computation.* (1.) Find the approx. time of Passage, No. 630; to this reduce the declin., in the case of the sun, moon, or a planet

(2.) Add together the log. sine of the declin., and the log. cosec. of the lat; the sum is the log. sine of the true alt. required.

Ex. 1. July 12th, 1878, lat. 51° 48′ N., long. 4° 56′ W.: find the Sun's Alt. on the Prime Vertical, W.

Table 29, Lat. 52°, Decl. 22°, Hour-angle, or App. Time	4ʰ 46ᵐ
Long. 4° 56′ W.	+ 20
Green. Date 12th,	5 6
⊙ Decl. 12th,	21° 58′ N.
13th,	21 50 N.
Daily Var.	8

Daily Var. 8′ and 5ʰ gives 2′, whence Red. Decl. is 21° 56′

Decl. 21° 56′	sine	9·57232
Lat. 51 48	cosec.	0·10466
Alt. 28 23	sine	9·67698

Ex. 2. Lat. 50° 48′ N.: find the Alt. of α Lyræ on the Prime Vertical.

Decl. 38° 40′	sine	9·79573
Lat. 50 48	cosec	0·11073
Alt. 53 44	sine	9·90646

Ex. 3. Lat. 46° 14′ N.: find the Alt. of Capella on the Prime Vertical.

Decl. 45° 52′	sine	9·85596
Lat. 46 14	cosec.	0·14136
Alt. 83 38	sine	9·99732

[3.] *To find the Altitude, the Hour-angle being given.*

666. *By Inspection.* See Explan. of Table 5.

667. *By Computation.* Having (in the case of the sun, moon, or planet) found the Gr. Date and the declination.

Take the suppl. of the hour-angle to 12ʰ; add together the pol. dist. and colat.

Add together the log. sine square of the suppl. of the hour-angle, and the log. sines of the pol. dist. and colat.; the sum (rejecting tens) is the log. sine square of an auxiliary arc x

Write x under the sum of the pol. dist. and colat. and take the sum and diff., and half the sum and half the diff.

Add together the log. sines of the last two terms; the sum (rejecting tens) is the log. sine square of the zen. dist.

Ex. 1. Lat. 22° 15′ N., decl. 2° 49′ S., hour-angle 2ʰ 14ᵐ 36ˢ: required the Alt. (working to the nearest minute).

Hour-angle	2ʰ 14ᵐ 36ˢ		
Suppl.	9 45 24	sin. sq.	9·96200
P. Dist.	92 49′	sine	9·99947
Colat.	67 45	sine	9·96639
Sum	160 34		
Arc x	133 57	sin. sq.	9·92786
Sum	294 31		
Diff.	26 37		
½ S.	147 15	sine	9·73318
½ D.	13 18	sine	9·36182
Zen. Dist.	41° 19′	sin. sq.	9·09500
Alt.	48 41		

Ex. 2. Lat. 35° 15′ N., decl. 20° 0′ N., hour-angle 4ʰ 53ᵐ 19ˢ. Alt. 24° 41′.

Ex. 3. Lat. 19° 20′ S., decl. 19° 20′ S., hour-angle 1ʰ 18ᵐ 10ˢ. Alt. 71° 35′.

When the lat. is 0, we may use either N. or S. pol. dist. When the declin. is 0, the pol. dist. is 90°. When both lat. and declin. are 0, the z. d. is the hour-angle converted into arc.

Ex. 1. Lat. 0, decl. 23° 27′ N., hour-angle 4ʰ 30ᵐ 14ˢ. Alt. 20° 30′.

Ex. 2. Lat. 30° 0 N., decl. 0, hour-angle 3ʰ 38ᵐ 30ˢ. Alt. 30° 5′.

[4.] *To find the Altitude, the Azimuth being given.*

668. Add together the log. sine of the azim., the log. cosine of the lat., and the log. sec. of the decl.; the sum (rejecting tens) is the log. sine of an angle A (see note to No. 616), p. 222.

Under A put the azim. reckoned from the elevated pole; take half the sum and half the diff.

Take half the sum of the pol. dist. and colat.

Add together the log. tan. of this half sum, the log. cos. of the half sum of the azim. and A, and the log. sec. of their half diff.; the sum (rejecting tens) is the log. tan. of half the zen. dist.

Ex. Lat. 51° 30′ N., decl. 20° 2′ N., azimuth S. 69° 39′ W., that is **N. 110° 21′ W.**: required the Alt.

Az.	69° 39′	sin.	9·97201
Lat.	51 30	cos.	9·79415
Decl.	20 2	sec.	0·02711
A =	38° 25′	sin.	9·79327
Az.	110 21		
Sum	148 46,	½ S.	74° 23′
Diff.	71 56,	½ D.	35 58

Colat.	38° 30				
P. Dist.	69 58				
Sum	108 28,	½ S.	54° 14	tan.	0·14246
			74 23	cos.	9·43007
			35 58	sec.	0·09186
			24° 47′	tan.	9·66439
			2		
	Zen. Dist.		49 34		
	Alt.		40 26		

For other Examples reverse those in No. 674.

6 *To find the Change of Altitude in a Small Interval of Time.*

[1.] *The Hour-angle and Altitude being given.*

669. (1.) When the body is to the E. of the meridian, ***subtract*** half the interval from the hour-angle; when to the W. of the meridian, *add* half the interval: call the result the reduced hour-angle.

(2.) Add together the log. cosines of the lat. and declin., the log. sine of the red. hour-angle, the log. sec. of the alt. and the log. sine of the interval; the sum (rejecting tens) is the log. sine of the change of alt.*

(3.) When the body is to the E. of the meridian, *add* this change to the alt.; when to the W., *subtract* it: the result is the alt. required.

Ex. 1. Lat. 51° 30′, decl. 22° 20′, true alt 44° 47′ 36″, hour-angle $3^h\ 0^m\ 0^s$ to the E. of the meridian: required the Alt. 10^m afterwards.

Hour-angle	$3^h\ 0^m\ 0^s$ E.	lat. cos.	9·7942
Half-int.	− 5 0	decl. cos.	9·9661
Red. H. ang.	2 55 0	sine	9·8398
	44° 47′ 36″	sec.	0·1490
		int. sin.	8·6397
Change	1 24 1	sin.	8·3888
Alt.	46 11 37		

The true alt. is 46° 12′ 48″, or the process is here 1′ 11″ in defect.

Ex. 2. Lat. 51° 30′, decl. 22° 20′, true alt. 44° 47′ 36″, hour-angle $3^h\ 0^m\ 0^s$ to the W.: find the Alt. 20^m afterwards.

	$3^h\ 0^m\ 0^s$ W.	lat. cos.	9·7942
	+ 10 0	decl. cos.	9·9661
	3 10 0	sine	9·8676
	44 47′ 36″	sec.	0·1490
		int. sine	8·9403
	2 59 20	sin.	8·7172
Alt.	41 48 16		

The true alt. is 41° 52′ 24″, or the error is 4′ 8″ in consequence of the length of the interval.

* The prop. logs. may be used for the sines of the small arc and the interval, provided that the arithmetical complements of all the other quantities be employed, and the const. 8·8239 added. The proper logarithm for the purpose is the log. of the small arc or the interval in seconds of arc (″). The inaccuracy attending the use of the sine, instead of its arc, in these computations is insensible, as the sine of 1° falls short of its arc by only 0″·2, the sine of 2° by 1″·5, and that of 3° by 2″·9, or 0^s·19 of time.

The method is more accurate as the object is more nearly E. or W.

The proper alt. to employ in this computation is the middle alt. between those at the beginning and end of the interval; for greater accuracy, therefore, the work should be repeated with a new alt. thus deduced.

[2.] *The Azimuth being given.*

670. *By Inspection.* Multiply the change of alt. in 1^m of time, Table 46, by the interval, both being in min. and decimals.

Ex. Lat. 52°, azim. 72°: find the change in Alt. in $3^m\ 12^s$.
The change of alt. in 1^m is about 8'·7, which multiplied by 3·2 gives 28', the CHANGE required.

671. *By Computation.* Add together the log. sine of the azimuth (reckoned either from N. or S.), the log. cos. of the lat., and the log. sine of the interval of time; the sum (rejecting tens) is the log. sine of the change of altitude.

It is more correct to use the azimuth corresponding to the middle of the interval of time.*

Ex. Lat. 51° 49', azimuth of Arcturus 72°: find the change of Alt. in $3^m\ 12^s$, and also in $2^m\ 51^s$.

Az. 72°	sine 9·9782			9·9782
Lat. 51 49'	cos. 9·7911			9·7911
Int. $3^m\ 12^s$	sine 8·1450	Int. $2^m\ 51^s$		8·0946
CHANGE req. 28' 13"	sine 7·9143	CHANGE req. 25' 8"	sine	7·8639

672. All bodies on the same or opposite azimuths change their altitudes at the same rate, whatever be their declinations.

VII. AZIMUTHS.

1. *To find the Azimuth, the Altitude being given.*

673. *By Inspection.* See Explanation of Table 5.

674. *By Computation.* Add together the pol. dist., the lat., and the alt., take half the sum,† and take the diff. between this half sum and the pol. dist.

Add together the log. sec. of the lat., the log. sec. of the alt., the log. cosines of the half sum and remainder; the sum (rejecting tens) is the log. sine square of the azimuth,‡ to be reckoned from the S. in N. lat., and from the N. in S. lat.

* The above rules, Nos. 669, &c., relate to the change of the *true* altitude. To compare the change of alt. as shewn by an instrument with the true difference, in a given interval of time, a small correction would, in general, be necessary, on account of the change of refraction, and in the case of the moon, for the change also in her parallax in altitude.

† The learner will observe that in this formula the pol. dist., lat., and alt., occur in the *reverse* order of that in No. 614, in which last their initials form the word *alp*. The 2d and 3d terms take secants; the last two, cosines.

‡ The angle obtained is the *supplement* of the angle P Z A in fig 1, p. 162

Ex. 1. Lat. 51° 30′ N., alt. 40° 25′ to the W., decl. 20° 2′ N.: required the Azimuth.

Pol. Dist.	69° 58′		
Lat.	51 30	sec.	0·20585
Alt.	40 25	sec.	0·11842
	161 53		
	80 56½	cos.	9·19711
	10 58½	cos.	9·79198
AZIMUTH, S. 69° 39′ W.		sin. sq.	9·51336

Ex. 2. Lat 40° 8′ S. decl. 11° 0′ N. alt. 38° 11′ to the Eastward: required the Azim.

P. Dist.	101° 0′		
Lat.	40 8	sec.	0·1106
Alt.	38 11	sec.	0·1046
	179 19		
	89 39½	cos.	7·7755
	11 20½	cos.	9·9914
AZIMUTH, N. 11° 19′ E.		sin. sq.	7·9881

When the lat. is 0, if the declin. is N. the azimuth is to be reckoned from the south; if it is S. from the north.

When the declin. is 0, the azimuth is reckoned from the N. in S. lat., and from the S. in N. lat.

Ex. 1. Lat. 0°, decl. 23° 27′ S., alt. 41° 2′ W. AZIM. N. 121° 50′ W., or S. 58° 10′ W.

Ex. 2. Lat. 11° 12′ N., decl. 0°, alt. 54° 30′, to the East. AZIM. S. 73° 53′ E.

When both the lat. and decl. are 0, the object moves on the prime vertical.

2. *To find the Azimuth, the Hour-angle being given.*

675. (1.) Take half the sum of the pol. dist. and colat., and half the difference.

(2.) Add together the log. cot. of half the hour-angle, the log. sec. of the half sum, and log. cos. of the half diff.: the sum (rejecting tens) is the log. tan. of half the sum of the azimuth and another angle A.

When the half sum of the pol. dist. and colat. exceeds 90°, take the suppl. of the resulting arc for the half sum required.

To the log. cot. already employed add the log. cosec. of the half sum, and the log. sine of the half diff.; the sum (rejecting tens) is the log. tan. of half the diff. of the same two angles.

(3.) The *sum* of the resulting half sum and half diff. is the *greater* of the said two angles; the *difference* is the *lesser*.

When the pol. dist. exceeds the colat. the greater of the two angles is the azimuth required; when the pol. dist. is *less* than the colat., the *lesser* of the angles is the azimuth required

Ex. 1. Lat. 10° 20′ N., decl. 22° 14′ S., hour-angle $1^h 44^m 17^s$ W.: required the Azimuth.

H. Angle	$1^h 44^m 17^s$					
Half	0 52 8		cot. 0·63548		cot.	3·63548
P. Dist.	112° 14′					
Colat.	79 40					
Sum	191 54					
Diff.	32 34					
½ S.	95 57		sec. 0·98439		cosec.	0·00235
½ D.	16 17		cos. 0·98222		sin.	9·44776
		88° 34′	tan. 1·60209	50° 37′	tan.	0·08559
		91 26 (suppl.)				
		50 37				
Sum	N.	142 3	W. AZIMUTH (p. dist. exceeds col.)			
Diff.		40 49	the other Angle, or A.			

Ex. 2. Lat 47° 11′ S., decl. 11° 18′ S., hour-angle $5^h 11^m 20^s$: the Azimuth 91° 6′, the other angle, or A, 43° 52′.

Ex. 3. Lat. 13° 52′ N., decl. 46° 8′ N., hour angle $1^h 21^m 11^s$ E. of Mer.

AZIM. 33° 47½′ E.

3. *To find the Azimuth, the Hour-angle and Altitude being given.*

676. Add together the log. sine of the pol. dist. (or log. cos. of the declin.), the log. sine of the hour-angle, and the log. sec. of the alt.; the sum rejecting tens is the log. sine of the azimuth.

Ex. 1. Hour-angle $1^h\ 19^m\ 19^s$, alt. 58° 40′, pol. dist. 104° 24′: required the Azimuth.

Pol. Dist. sin.		9·9861
Hour-angle sine		9·5305
Alt. sec.		0·2840
AZIM. 39° 11′	sin.	9·8006

Ex. 2. Hour-angle $0^h\ 46^m\ 39^s$, alt. 63° 0′, decl. 14° 24 (N. or S.): required the Azimuth.

Decl. cos.		9·9861
Hour-angle sin.		9·3057
Alt. sec.		0·3430
AZIM. 25° 33′	sin.	9·6348

This method cannot shew whether the body is to the N. or S. of the prime vertical; for this purpose see No. 673, &c.

4. *To find the Azimuth, not far from the Meridian, by the observed change of Altitude in a small Interval of Time.*

677. *By Inspection.* Divide the given change of alt. by the interval, in min. and decimals; the quotient is the change of alt. in 1^m.

With this change and the lat. enter Table 46, and take out the azimuth, which corresponds approximately to the middle of the interval.

Ex. Lat. 35°; the change of alt. in $20^m\ 12^s$ is 59′: find the Azimuth.

59 divided by 20·2 gives 2·9, the change of alt. in 1^m, which gives the AZIM. about 14°.

678. *By Computation.* Add together the log. sine of the change of alt., the log. cosec. of the interval, and the log. sec. of the lat.; the sum is the log. sine of the azimuth about the middle of the interval.

Ex. 1. Lat. 51° 26′; in $5^m\ 20^s$ observed 22′ change of alt.: required the Azimuth.

D. Alt 22′	sine	7·8061
Int. $5^m\ 20^s$	cosec.	1·6332
Lat. 51° 26′	sec.	0·2052
AZIM. 26° 10′	sine	9·6445

At about 3^m after the 1st observation.

Ex. 2. Lat. 34° 40′; in $20^m\ 12^s$ observed 59′ 6″ change of alt.: required the Azimuth.

D. Alt 59′ 6″	sine	8·2353
Int. $20^m\ 12^s$	cosec.	1·0554
Lat. 34° 40′	sec.	0·0849
AZIM. 13° 44′	sine	9·3756

At about 10^m after the 1st observation.

679. This method will sometimes be useful, as for determining the variation, but it must be employed with caution; the interval should not be very small, the body should not be far from the meridian, and both alts. must of course be observed on the same side.

The degree of dependance is easily estimated by changing the diff. of alts. by the amount of probable error, as about 1′ or 2′: Thus, 1′ error of diff. alts. produces in Ex. 1 an error of 1°½, while in Ex. 2 it produces an error of only 14′. *

* The work of finding the Azimuth is much lessened by the use of suitable tables. Burdwood and Davis's Azimuth tables and Star Azimuth tables extend from the equator to 60° latitude, and are published in a convenient form by J. D. Potter, 145 Minories, London, E. Such tables are indispensable for the navigation of iron ships. *See also* Lecky's "Wrinkles," for stars.

CHAPTER V.

Finding the Latitude.

I By the Meridian Altitude. II. By the Reduction to the Meridian. III. By Double Altitude of the same Body. IV. By Double Altitude of different Bodies. V. By the Altitude of the Pole Star.*

680. The pole remains always in the same absolute fixed position from whatever point of the earth's surface it is viewed; its altitude at any particular place is, therefore, always the same. The position of the equator, which is 90° from the pole, is also always the same at the same place, and is determined by reference to the celestial bodies, whose declinations are measured from it. The latitude of the place may, therefore, be determined directly by observation, and independently of the latitude of any other place.

When the body observed is on the meridian (at which time its altitude ceases to change) the time is not noted; but if it is not on the meridian, either the absolute time must be given, or a second altitude must be obtained after a measured interval.

I. By the Meridian Altitude.

681. The simplest, and in general the most satisfactory, method of determining the latitude, is by observation of the altitude of a celestial body when on the meridian of the place.†

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* The several methods of latitude which are given in this work under the heads enumerated above, and which may be considered as distinct methods, of which the solution depends on circumstances as elsewhere described, amount to eight. The seaman, who will remember the adage, "lead, latitude, and look-out," scarcely needs to be reminded that the latitude is often the only element necessary,—that headlands on vast tracts of coast are approached, and numerous passages or channels taken, by reference to latitude alone,—and that the time, and therefore the longitude itself, depends on the latitude. In these days, also, when such great and continued velocity is attained, in steam-vessels, increased facilities are demanded for determining the place of the ship from time to time; the seaman accordingly should be furnished with a method of finding the latitude (provided it be convenient and satisfactory) adapted to every occasion that may present itself by day and by night

† The manner of deducing the latitude from the mer. alt. and declin. is fully described in No. 452.

1 *Meridian Altitude of the Sun.*

682. *The Observation.* When the sun is near the meridian, continue to observe the altitude till it is found to decrease; the *greatest* alt. reached is the mer. alt.*

In latitudes above 66°½ the sun, being above the horizon the whole 24 hours during part of the summer months, may often be observed below the pole at midnight; in this case the *smallest* altitude is the mer. alt.†

When accuracy is required, note the barom. and therm.

683. *The Computation. At Sea.* (1.) Take the sun's decl. from the Nautical Almanac, page I., or Table 60, for the noon of the day, and reduce it by Table 19 for the longitude by account.

(2.) Correct the alt. for index error, dip, semidiameter, and refraction, No. 647; subtract it from 90°, the remainder is the zenith distance.

(3.) When the observer is to the N. of the sun, call the zen. dist. *north;* when he is to the S. of the sun, call it *south.*

When the zen. dist. and decl. are of the *same* name, take their *sum;* when of *contrary* names, take their *difference:* the result is the lat.

When the decl. and zen. dist. are of the *same name*, the lat. is also of *that name;* when the decl. and zen. dist. are of *different* names, the lat. takes the name of the *greater*.‡

Ex. 1. May 3d, 1902, long. 38° W., obs. Mer. Alt. ⊙ 56° 10′ to the southward, ind. corr. +2′, height of eye 20 feet: required the Latitude.

Decl. 3d, Table 60,		15° 29′ N.
Corr. for 38° W.		+2
Red. Declin.		15 31 N.
Obs. Alt. ⊙	56° 10	
Ind. Corr. +2′, Dip −4	−2	
App. Alt. ⊙	56 8	
Refr. −1′, Semid. +16	+15	
True Alt.	56 23	
Zen. Dist.	33 37	33 37 N.
LATITUDE		49 8 N.

Ex. 2. July 4th, 1902, long. 101° E.; obs. Mer. Alt. ⊙ 81° 59′ bearing north, ind. corr. 0, height of eye, 16 feet: required the Latitude.

Decl. 4th,		22° 57′ N.
Corr. for 101° E.		+1
Red. Declin.		22 58 N.
Obs. Alt.	81° 59	
Table 38,	+12	
True Alt.	82 11	
Zen. Dist.	7 49	7 49 S.
LATITUDE		15 9 N.

* At sea it is usual to keep advancing the index till the sun has *dipped*, but it is better to take separate altitudes.

† Since the sun, moon, and planets, change their declinations, the mer. alt. is not always the *maximum* or *minimum* altitude. Near the equator the difference, which is as the tangent of the latitude nearly, is very minute. In lat. 60° the sun's alt. will be maximum, in the extreme case, at half a min. from the meridian, and the altitudes will differ only 0″·4; in the same latitude these quantities will be, for the moon, 7′ and 2′ respectively. As 0″·4 is inappreciable by ordinary instruments, and as the moon can be employed for approximation only, it is not necessary to tabulate this correction.

‡ A ship, on board which the declination had been applied the wrong way, made the Orkney Islands, in coming from the westward, instead of the Channel. A few years ago a ship bound homewards from Australia round C. Horn got too far to the southward; a similar

When the declin. is 0, the zen. dist. is the latitude; and when the zen. dist. is 0, the declin. is the latitude.

Ex. 3. March 21st, 1902, long. 15° W.; obs. mer. alt. ☉ 48° 16′ bearing N., index error − 5′, eye 16 feet. find the Latitude.

Decl. 21st		0° 1′ S.
Corr. for long. 15° W.		− 1
Red. Decl.		0 0
Obs. Alt. ☉		48° 16′
Index	− 5′	
Semi.	− 16	− 26
Dip	− 4	
Ref.	− 1	
True Alt.		47 50
Zen. Dist.		42 10 S.
Decl.		0 0
LATITUDE		42 10 S.

Ex. 4. July 13th, 1902, long. 49° W.; obs. mer. alt. ☉ 89° 44′ N., index error + 4′, eye 18 feet: find the Latitude.

Decl. 13th		21° 56 N.
Corr. for long. 49° W.		− 1
Red. Decl.		21 55 N.
Obs. Alt. ☉		89° 44′
Index	+ 4′	+ 16
Table 38	+ 12	
True Alt.		90 0
Zen. Dist.		0 0
Decl.		21 55 N.
LATITUDE		21 55 N.

Ex. 5. March 21st, 1902, long. 60° E., obs. mer. alt. ☉ 56° 26′ N., index error + 2′, eye 20 feet; required the Latitude. Red. decl. 0° 5′ S. True alt. 33° 21′.
LAT. 33° 26′ S.

Ex. 6. Aug. 5th, 1902, long. 47° W., obs. mer alt. ☉ 72° 47′ N., index error + 2′, eye 16 feet. Red. decl. 17° 8′ N. True alt. 73° 1′. LAT. 0° 9′ N.

Ex. 7. March 20th, 1902, long. 90° W., obs. mer. alt. ☉ 89° 48′ S., index error − 1′, eye 12 feet. Red. decl. 0 19′ S. True alt. 90°. LAT. 0° 19′ S.

Ex. 8. Jan. 1st, 1902, long. 138° W., obs. mer. alt. ☉ 89° 55′ S., index error + 2′, eye 12 feet. Red. decl. 23° 3′ S. True alt. 90° 10′. LAT. 23° 13′ S.

Ex. 9. June 20th, 1902, long. 172° W., obs. mer. alt. ☉ 52° 18′ S., index error − 2′, eye 60 feet (the top). Red. decl. 23° 27′ N. True alt. 52° 23′. LAT. 61° 4 N.

Ex. 10. Feb. 18th, 1902, long. 71° E., obs. alt ☉'s centre (by bisecting the cloudy disc. No. 539), 48° 22′ S., eye 18 feet. Decl. 11° 55′ S. True alt. 48° 17′.
LAT. 29° 48′ N.

Ex. 11. Dec. 20th, 1902, long. 160° E., obs mer. alt. ☉ 28° 18′ S., above the sea horizon $2\frac{1}{2}$ miles distant, eye 20 feet. Red. decl. 23° 25′ S. True alt. 28° 26′.
LAT. 38° 9′ N.

684. When the sun is observed below the pole (at midnight), instead of subtracting the true alt. from 90°, add 90° to it; the lat. will be of the same name as the declin.

Ex. 1. June 5th, 1902, long. 20° E. at 12^h P.M., obs. mer. alt. ☉ below the pole 3° 38′ N., ind. corr. + 2′, height of eye 20 feet: required the Latitude.

Red. Declin. No. 579 (2),		22° 31′ N.
Obs. Alt. ☉		3 38′
Ind. Corr.	+ 2′	− 2
Dip.	− 4	
		3 36
Refr.	− 13′	+ 3
Semid.	+ 16	
True Alt.		3 39
Supp. Zen. Dist.		93 39
Decl.		22 31 N.
LATITUDE		71 8 N.

Ex. 2. Nov. 13th, 1902, long. 98° W. at 12^h P.M., obs. mer. alt. ☉ below the pole 5° 37′ S., ind. corr. − 2′, height of eye 30 feet.

Declin. Noon		17° 48′ S.
Corr. for 12^h *add* 8′		12
98 W. *add* 4		
Red. Declin.		18 0 S.
Obs. Alt.		5° 37′
Ind. Corr.	− 2′	0
Table 38	+ 2	
True Alt.		5 37
Supp. Zen. Dist.		95 37
Decl.		18 0 S.
LATITUDE		77 37 S.

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blunder was discovered to have been made, but the existence of an error in the latitude was suspected only from the circumstance of the ship being beset with ice.

In crossing the meridian of 180°, when the long. changes from W. to E., or from E. to W., care must be taken to change the application of the corr. of the declin. accordingly. The neglect of this precaution has been a fertile source of mistakes.

685. *Accurately.* Reduce the declin. to the nearest second for the long., correct the refraction for the barom. and therm. and add the sun's parallax.

As the sun passes the meridian at $0^h\ 0^m\ 0^s$ App. Time, the Greenwich Date may be deduced in App. Time by means of the long. in time, No. 576 (3). Or it may be taken at once from the chronometer, in which case it will be in Mean Time, as is supposed in Ex. 1, following.

Ex. 1. March 20th, 1878, long, 1° 25′ W., obs. mer. alt. ☉ in the mercury 69° 8′ 10″ bearing S., time by chron. $20^d\ 0^h\ 13^m\ 12^s$, index error + 1′ 10″, bar. 29·5 inches, therm. 40°.

☉'s Decl. 20th	0° 5′ 38″·7 S.
21st	0 18 2·4 N.
Daily Var.	23 41·1
$13^m 12^s$, var. 23′ 41″	−12 6
	0 5 38·7 S.
Red. Decl.	0 5 26·1 S.
Obs. Alt.	69° 8′ 10″
	+1 10
	2)69 9 20
	34 34 40
Ref. −1′ 25″, Ther. + 2, Bar. − 1	−1 24
	34 33 16
Semid.	+16 5
Par.	+ 7
True Alt.	34 49 28
Zen. Dist.	55 10 32 N.
Decl.	0 5 26 S.
LAT.	55 5 6 N.

Ex. 2. June 20, 1878, long. 26° 5′ E., at midnight, obs. mer. alt. ☉ in the quicksilver 26° 26′ 20″, index 0′, bar. 29·8 inches, therm. 34°.

Green. Date, A T. June $20^d\ 10^h\ 15^m 40^s$

Reduced Decl.	23° 27′ 16″ N
Obs. Alt.	26° 26′ 20″
	13 13 10
Ref. −4′ 4″, Ther. + 8, Bar. − 1	−3 57
	13 9 13
Semidiam.	+15 46
Par.	+ 8
True Alt.	13 25 7
Supp. Zen. Dist.	103 25 7
Decl.	23 27 16 N.
LAT.	79 57 51 N.

Ex. 3. July 27th, 1878, long. 2° W., obs. mer. alt. ☉ in the quicksilver 116 2′ 30″, zenith N. ind. corr. + 2′ 15″, bar. 30·0 inch., therm. 60°: required the Latitude.

Green. Date (A.T.), $27^d\ c^h\ 8^m$; Red. Decl. 19° 12′ 17″ N.; True Alt. 57° 46′ 4″: LAT. 51° 26′ 13″ N.

686. When the altitude of either limb of the sun is observed, and the alt. of the other limb (which will appear the *same* in the instrument) is observed from the opposite point of the horizon (No. 535), take half the diff. of these angles and *add* to it the correction of alt.; the sum is the true zen. dist.

Ex. 1. Aug. 5th, 1878, long 25° W.

Obs. Alt. ☉ N.	115° 46′·3
S.	63 49·3
Diff.	51 57
	25 58·5 N.
Corr. of Alt.	+·4
Zen. Dist.	25 58·9 N.
Red. Decl.	16 56·3 N.
LAT.	42 55·2 N.

Ex. 2. Oct. 20th, 1878, long. 1° W.

Obs. alt. ☉ N.	105° 5′
S.	74 32·2
Diff.	30 32·8
	15 16·4 N.
Corr. of Alt.	+ ·2
Zen. Dist.	15 16·6 N.
Red. Decl.	10 23·9 S.
LAT.	4 52·7 N.

Thus it appears that this observation, which is the most efficient in practice, is also the shortest in computation.

Ex. 3. July 15th, 1878, alt. ☉ N. 93° 58′, S. 85° 38′, long. 71° W. LAT. 25° 39′·7 N.

Ex. 4. July 4th, 1878, alt. ☉ N. 81° 59′, S. 97° 4′, long. 83° E. LAT. 15 3′·7 N.

2. *Meridian Altitude of a Star or a Planet.**

687. *The Observation* is the same as for the sun, but it is still more necessary to take separate altitudes of a star in order to avoid straining the eye to perceive its small rise or fall when near the meridian. See No. 542.

688. *The Computation. At Sea.* (1.) Take the decl. either from the Nautical Almanac, or, in the case of a star, from Table 63.

(2.) Correct the alt. for index-error, dip, and refraction, No. 652. Find the zenith dist. and proceed as for the sun.

Ex. 1. May 15th, 1878, obs. mer. alt. of Spica 33° 17′ S. index error + 1′ 20″, eye 30 feet.

Obs. Alt.		33° 17′ S.
Index err.	+ 1′	
Dip	− 5	− 5
Ref.	− 1	
True Alt.		33 12 S.
Zen. Dist.		56 48 N.
Star's Decl.		10 32 S.
Lat.		46 16 N.

Ex. 2. April 9th, 1878, P.M. long. 126° W., obs. alt. of Mars 49° 20′ N., index corr. + 3′, eye 16 feet.

In N. A. page 244, the M.T. of mer. pass. of Mars is Aug. $9^d\ 3^h\ 36^m$. The Green. Date is Aug. $9^d\ 12^h\ 0^m$, and the Red. Decl. is 23° 39′ N.

Obs. Alt.		49° 20′ N.
Index Corr.	+ 3′	
Dip	− 4	− 2
Ref.	− 1	
True Alt.		49 18
Zen. Dist.		40 42 S.
Red. Decl.		23 39 N.
Lat.		17 3 S.

Ex. 3. Dec. 21st, 1878, obs. mer. alt. Aldebaran 50° 27′ N.; height of eye 20 feet; required the Latitude. Lat. 23° 22′ S.

Ex. 4. Jan. 1st, 1878, obs. mer. alt. Sirius 81° 13′ S., ind. corr. − 4′, height of eye 18 feet: required the Latitude. Lat. 7° 38′ S.

Ex. 5. Feb. 18th, 1878, obs. mer. alt. Canopus 37° 25′ S., ind. corr. + 2′, height of eye 16 feet: required the Latitude. Lat. 0° 0′

Ex. 6. Feb. 1st, 1878, obs. mer. alt. Arcturus 80° 12′ N., ind. corr. + 3′, height of eye 18 feet: required the Latitude. Lat. 10° 1′ S.

Ex. 7. Feb. 18th, 1878, obs. mer. alt. α Lyræ below the pole, 12° 30′, ind. corr. + 2′, height of eye 18 feet: required the Latitude. Lat. 63° 44′ N.

Ex. 8. Oct. 6th, 1878, long. 87° W., obs. mer. alt. Mars 57° 45′ S., index corr. − 2′, height of eye 18 feet. Lat. 30° 15′ N.

Ex. 9. July 6th, 1878, long. 178° E., obs. mer. alt. Jupiter 57° 50′ S., index corr. + 3′, height of eye 20 feet. Lat. 15° 2′ N.

Ex. 10. Jan. 6th, 1878, long. 169° W., obs. mer. alt. Venus 69° 54′ S., index corr. 1′, height of eye 15 feet. Lat. 9 15′ N.

689. *Accurately.* Take the decl. from the Nautical Almanac. For a planet find the Gr. Date, and reduce its hor. par. and decl. Correct the refraction for the thermometer and barometer.

690. Stars which never set at the place may be observed both above and below the pole. In this case the latitude is half the sum of the altitudes corrected for refraction.

691. If two stars are observed on the meridian, on different sides of the zenith, and at equal altitudes, the result is independent of the refraction, unless it changes in the interval of the observations. If the altitudes are not equal, the result involves only the difference of the refractions proper to each.

* Venus may often be observed by daylight, even in high latitudes.

3. *Meridian Altitude of the Moon.*

692. *The Observation.* The same as for the sun. See No. 540.

693. *The Computation. At Sea.* (1.) Find the Green. Date by means of the time at ship; or, if this time is uncertain several minutes, find the M.T. of the moon's mer. pass., No. 627, &c. Reduce thereto the moon's decl., No. 589, her hor. par., and take the corresponding semid. from Table 40, all to the nearest minute.

(2.) Correct the observed alt., No. 654, and proceed as for the sun, No. 683 (3).

Ex. 1. Nov. 3d, 1878, long 150° 15′ E., at $7^h\ 7^m$ P.M. mean time at ship, obs. alt. ☽ 45° 13′ S., height of eye 16 feet.

M.T.S. Nov.	3^d	7^h	7^m	
Long. in time		−10	1	E.
M.T.G. Nov.	2	21	6	
☽'s Decl. at 21^h	14°	47′	45″	S.
6^m, var. 119″		−1	11	
Red. Decl.	14	46	34	S.
Hor. Par.	54′ 50″			
Semid.	14 58			
Obs. Alt. ☽		45°	13	
Dip −4, Semid. +15			+11	
		45	24	
45° 20′, and H.P. 55′			+38	
True Alt.		46	2	
Zen. Dist.		43	58	N.
Decl.		14	47	S.
LAT.		29	11	N.

Ex. 2. May 20th, 1878, A.M. long. 114° W., obs. mer. alt. ☽ 48° 48′ S., height of eye 18 feet.

Moon's Mer. Pass.	19^d	15^h	12^m	
Corr. for Long.			+16	
M.T. Mer. Pass. at ship	19	15	28	
Long. in time		7	36	
M.T.G. May	19	23	4	
☽'s Decl. at 23^h	24°	34′	22″	S
4^m, var. 69″			−8	
Red. Decl.	24	34	14	S.
Hor. Par.	56′ 33″			
Semid	15 26			
Obs. alt. ☽		48°	48	
Dip − 4′, Semid. −16			−20	
		48	28	
48° 30′ and H.P. 57′			+37	
True Alt.		49	5	
Zen. Dist.		40	55	N.
Decl.		24	34	S.
LAT.		16	21	N.

Ex. 3. Dec. 21st, 1878, A.M. long. 149° W., obs. mer. alt ☽ 84° 9′ N. index corr. + 2′, height of eye 14 feet.

LAT. 31° 14′ S.

Ex. 4. Aug. 10th, 1878, P.M. long. 134° E., obs. mer. alt. ☽ 59° 44′ N., index corr. − 1′, height of eye 18 feet.

LAT. 53° 48′ S.

It will in general be loss of time to work nearer than to minutes, because the moon's declination cannot be found to seconds unless the Greenwich time is known with precision.*

694. When both the upper and lower limbs are well defined, the suppl. of the alt. can be observed, and the precept No. 683 applied. When only one limb can be observed, the semi-diameter must be applied.

695. *Degree of Dependance.* The error of the resulting lat. is obviously the sum or difference of the errors of alt. and decl. The lat. by the sun at sea may be depended upon within 2′ or less, that by the moon not so nearly, and the lat by a single star in a dark night perhaps not within 3′ or 4′.

* Also as the moon at certain times changes her declination very rapidly, or 17′ an hour, her mer. alt. may differ considerably from the maximum alt.; and an interval of several minutes may occur between these two altitudes. See note †, p. 244.

Errors of observation or of the instrument may be removed by employing celestial bodies of nearly equal altitudes N. and S. of the zenith.* (See No. 999.)

It may in general be considered that the lat. by mer. alt. is not decisively determined unless alts. on both sides of the zenith have been employed.

II. By the Reduction to the Meridian.

696. When the sky is cloudy, or the weather variable, the sun or any other celestial body, though obscured when exactly on the meridian, frequently appears, for short intervals of time, both before and after the meridian passage.†

When the body is near the meridian, the change of alt. in a small portion of time is very small; and though the altitude near the meridian changes at a different rate in different latitudes, yet the *change of altitude* in a given small interval is not sensibly affected by a change of several miles in the latitude, and therefore it may be computed with tolerable accuracy, even when the lat. by account (which is used in the computation) is considerably in error. If, accordingly, at the time of observing an alt. near the meridian, we know the hour-angle, we may find very nearly, by computation, the difference of alt. by which to reduce the observed alt. to the mer. alt., and which is thence called the *Reduction to the Meridian.*

This method is, in point of simplicity, but little inferior to the meridian altitude, to which it is next in importance; and it particularly demands the attention of seamen, because, when the latitude by observation is left, as it too generally is, to the casualty of obtaining the merid. alt., it is frequently lost for the day.

697. The term "near the meridian" implies a meridian distance limited according to the lat., the decl., and also the degree of precision with which the time is known. The Limits are given in Table 47 See also Explan. of the Table.

698. Since the lat. by acc. is employed in computing the Reduction, it may be necessary, when this lat. has been found to be much in error, to repeat the work.

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* Though the lat. by a single star may not be very correct, yet the error will in general be much less than that of the D.R. The altitude of a star also affords a certain check against the mistake of applying the sun's declination the wrong way; and it may be remarked, that a single observation of the kind would have prevented all the delay, wear and tear, and danger incurred in the cases mentioned in the note p. 244, from the ships being so far out of their proper latitudes.

† Capt. Sir Richard Grant remarks that in H.M.S. Cornwallis, alts. of the sun and stars were rarely to be obtained while within the limits of the Gulf Stream, but they had a momentary glimpse of the sun near noon once in two or three days.—Nautical Magazine, 1838, p. 437.

1. *Reduction to the Meridian at Sea.*

[1.] *By the Sun.*

699. *The Observation.* When the sun is within the limits in Table 47, observe two or three altitudes,* quickly, noting the times.

When the alts. are not observed very close together, either a separate result should be obtained from each alt. with its corresponding time, or the case should be solved by No. 727.

700. *The Computation.* (1.) Take the mean of the alts. and the mean of the times.

(2.) Find the sun's hour-angle, or the time from noon, thus:

1. When the App. Time has been lately *determined by observation.* If the ship has since made *westing, subtract* the diff. long. made good from the A.T. found; if she has made *easting, add* the diff. long. to the A.T.: the result is the A.T. required.

2. When the A.T. has *not* been lately determined by observation. Find A.T. by the chron. and the long. by acc., thus: To the G.M.T. (found by applying to the chron. the gain or loss up to the time) reduce the Eq. of T. and apply it to the G.M.T., as directed page II. of the Nautical Almanac, or the *contrary* way to that directed in Table 62: the result is A.T at Greenwich. In W. long. *subtract* the long in time from this Gr. T. (increased, if necessary, by 24^h); in E. long., *add* it: the result (rejecting 24^h if it exceed 24^h) is A.T. *at ship.*

When the A.T. of observation is P.M., it is the hour-angle required; when it is A.M., subtract it from 24^h: the rem. is the hour-angle.

If A.T. is near 12^h, subtract it from 12^h; if it exceed 12^h, reject 12^h: the rem. is the hour-angle from midnight.

Find the sun's decl., No. 579.

(3.) Correct the alt., No. 647.

(4.) Add together the logarithm from Table 70 and the log. sine square of the hour-angle: the sum is the log. sine of the Reduction.

(5.) *Add* the reduction to the true alt., unless the observation is near midnight, when *subtract* it: the result is the mer. alt. at the place where the alt. was observed; and the resulting lat. is the lat. of the ship at the time of observation (not at noon).

Having the mer. alt., proceed by No. 683 (3).

Ex. I. Aug. 5th, 1826. H.M.S. Leven, lat. by acc. 47° N.; long. by acc. 25° W. at $11^m 48^s$ before noon; obtained true alt. ☉ 63° 54′ to the southward: required the lat. The reduced decl. was 17° 4′ N.

Lat. 47, decl. 17 (*same* name)	0·416	Mer. alt.	64° 0′
$11^m 48^s$ sine sq.	6·821	Zen. dist.	26 0 N.
Red. 0° 6′ sin.	7·237	Red. decl.	17 4 N.
63 54		LAT.	43 4 N.
Mer. alt. 64 0		Repeating the work gives	43 3′

* As more than one altitude would, for greater security, always be obtained when possible, we shall, to avoid repetition, consider the term "altitude" in the subsequent rules and examples, as implying the mean of two or more altitudes corresponding to the mean of the times.

Ex 2. Lat 55° 6′ N., ⊙'s decl. 20° 4′ S., at 0ʰ 54ᵐ 12ˢ P.M., sun's true alt. 14 1′ S.: required the Latitude.

The Red. is 0° 54′, mer. alt 14° 55′, and the LATITUDE 55° 1′ N.

Ex 3. Feb. 23d, 1878, lat. by acc. 40° 5′ S., long. 132° E., at 11ʰ 45ᵐ 20ˢ A.M., obs. alt ⊙ 59° 40′ N., index corr. −2′, eye 20 feet: find the Latitude.

Red. decl. 9° 54′ S., true alt. 59° 49′, Red. 11′, LAT. 39° 54′ S.

Ex. 4. Dec. 12th, 1878, lat. by acc. 0° 0′, long. 162° W., at 0ʰ 11ᵐ 52ˢ P.M., obs. alt. ⊙ 66° 34′ S., index corr. −5′, eye 16 feet: required the Latitude.

Red. decl. 23° 7′ S, true alt. 66° 41′, Red. 11′, LAT. 0° 1′ N.

Ex. 5. June 21st, 1878, lat. by acc. 42° 18′ S., long 53° E., obs. alt. ⊙ 23° 41′ N. index corr. −1′, eye 14 feet; time by watch 0ʰ 50ᵐ 53ˢ P.M., fast on A.T. 14ᵐ 28ˢ, diff. long made since 20′ E.: find the Latitude.

Red. decl. 23° 27′ N., true alt. 23° 50′, Red. 35′, LAT. 42° 8′ S.

701. When the number of minutes of arc, in the Reduction, exceeds the number of minutes of time from the meridian, it is proper to refer to Table 48, to ascertain if it be necessary to employ the *Second Reduction.*

Ex. 1. (The preceding.) The number of min. in the Reduction, or 6, being less than the number of min. of time, or 11, it is not necessary to refer to the Table.

To Compute the 2d Red. Double the log. sine of the Red.; add to it the log. tan. of the mer. alt. found, and the constant 9·6990: the sum (rejecting tens) is the log. sine of the 2d Red.

This is to be *subtracted* from the 1st Red. (above the Pole), that is applied to the alt. the *contrary way* to that of the 1st Red.

Ex. 2. May 5th, 1878, lat. acc. 5° 3′ N., long. 71° 10′ E; time by watch 5ʰ 3ᵐ 7ˢ P.M., fast on app. time at ship 4ʰ 47ᵐ 27ˢ: obs. alt. ⊙ 77° 59′ N; height of eye 16 feet.

Time by Watch	5ᵈ	5ʰ	3ᵐ	7ˢ
Fast		−4	47	27
A.T.S.	5	0	15	40
Long. in Time		−4	44	40
A.T.G.	4	19	31	0

Decl.	16° 1′ N.	Obs. Alt.	77	59′
Corr.	+14	Table 38		+12
Red. Decl.	16 15 N.	True Alt.	78	11

Lat. 5°, Decl 16¼° (*same name*)				0·992
	0ʰ 15ᵐ 40ˢ		sin sq.	7·067
		39′	sin.	8·059
True Alt.	78	11		2
				6·118
	78	50	tang.	0·705
			const.	9·699
		−1	sin.	6·522
Mer. Alt.	78	49		
Zen. Dist.	11	11 S.		
Decl.	16	15 N.		
LAT.	5	4 N.		

Ex. 3. Jan. 6th 1878, A.M., lat. acc. 1° 10′ N., long. 58° E., at 8ʰ 4ᵐ 53ˢ by watch, 3ʰ 36ᵐ 28ˢ slow on A.T., long. made since 23′ W.; obs. alt. ⊙ 65° 13′ S, height of eye 16 feet: required the Latitude.

Red decl. 22° 30′ S., Red 31′, 2d Red. 0′, LAT. 1 34′ N

Ex. 4. Sept. 15th, 1878, lat. acc. 4° 58′ S., long. 110° W., at 0ʰ 11ᵐ 19ˢ P.M. A.T. obs. alt. ⊙ 81° 33′ N., index error −2′, eye 16 feet: find the Latitude.

Red decl. 2 52′ N., Red. 30′, 2d Red. 1′, LAT. 4 6′ S

702. If a second altitude, some time after the first, do not confirm the lat., the time is probably in error. In such cases the mean latitude is *not* to be taken as the true latitude, because that result which is nearest to the meridian is the best.

If the time only is in error, it will be easy to find, by trial, that time from noon which will make the two results agree; and thus this observation may serve to correct, approximately, the error of the watch. When the interval, however, between the alts. amounts to 6^m or 8^m, the case should be solved as a *Short Double Altitude*, No. 720.

[2.] *By a Star, a Planet, or the Moon.*

703. Compute the hour-angle: this must be done by means of the time at ship, by No. 611 or 612. But in general it will be better to observe the alt. of a star nearly E. or W., and to deduce its hour-angle, as directed in No. 737.

In other respects proceed as above directed. When the decl. exceeds 24°, the log., Table 70, must be computed.

704. *Degree of Dependance.* The error of the result is composed of that of the mer. alt., No. 695, together with that of the computed Red., which latter, when well within the limits of Table 47, will rarely be worth notice.

2. *Circummeridional Altitudes.*

705. On shore, when the time is accurately known, or even at sea under favourable circumstances, the result of several altitudes may be obtained by a computation which is the same in principle as the preceding, and is of much greater value than that of any single observation on or near the meridian.

[1.] *By the Sun.*

706. *The Observation.* When the sun is within the limits in Table 47, observe altitudes as fast as convenient, noting accurately the times by watch, of which the error on Apparent Time must be known or found as soon as possible afterwards.

When precision is required, note the barometer and thermometer.

707. *The Computation.* (1.) Find the Green. Date for noon at the place, in app. time, and reduce the decl. If the error of the watch is given on M.T., reduce also the Eq. of Time.

(2.) By means of the error of the watch obtain A.T. at each altitude. To these App. Times take out the Reduction in seconds from Table 49. Take the mean of the Reductions.

(3.) Find the mean of the alts., and correct it, No. 649 or 650. If the meridian alt. is not observed nearly, deduce it, No. 663, &c.

(4.) Add together the log. of the mean Reduction, the log. cos. of the lat. by acc., the log cos. of the decl., and log. sec. of the mer. alt.: the sum is the log. of the Reduction.

(5.) At *noon*, *add* the Reduction to the mean alt.; at *midnight*, *subtract* it: the result is the mer. alt.

Ex. 1. July 9th, 1836, lat. by acc. 51° 49′ N.; long. $0^h\ 3^m$ W.; obs. alts. of the sun's lower limb, near noon, by a sextant.

Times, by Watch.	Double Alt. ☉
$11^h\ 58^m\ 21^s$	120° 28′ 0″
0 0 47	120 30 30
0 3 40	120 32 37
0 25 46	120 7 0
0 30 39	119 51 40

At $11^h\ 55^m\ 1^s$ by watch the watch was $2^m\ 10^s\cdot 9$ fast on M T., and at $0^h\ 44^m\ 51^s$ it was $2^m\ 8^s\cdot 7$ fast.

Ind. corr. + 54″, barom. 29·8 inches, therm. 66°.

The observation being at noon in long. $0^h\ 3^m$ W., the Gr. Date is July 9th, $0^h\ 3^m$, app time.

The reduced Eq. of T. is $4^m\ 49^s\cdot 4$, *subtr.* from M.T.; red. decl. 22° 21′ 11″ N.

Error on App. T.	
T. by W.	$11^h\ 55^m\ 1^s$
Fast	2 11
M. T.	11 52 50
Eq. of T.	− 4 49
App. T.	11 48 1
T. by watch	11 55 1
W. fast on A.T.	7 0

Sum of Alts.	601° 29′ 47″
	120 17 57
	+ 54
	2) 120 18 51
	60 9 25
	+ 15 45
Mean Alt.	60 25 10
Approx. Mer. Alt.	60 32

App. Times	Reductions
$11^h\ 51^m\ 21^s$	146″·9
11 53 47	75 ·9
11 56 40	21 ·8
0 18 46	691 ·1
0 23 39	1097 ·2
	5) 2032 ·9
	406 ·6 log. 2·6092

60° Refr.	33″
Par.	− 4
Mean Corr.	29
Th. 61°, Alt 60°, −0″·9; Bar. 29·8, −0 ·2	− 1
True Corr.	28
	60 25 10
True Alt.	60 24 42

Lat.	cos.	9·7911
Decl.	cos.	9·9661
M. Alt.	sec.	0·3079
472″·4 log.		2·6743
472″ =		0° 7′ 52″
		60 24 42
Mer. Alt.		60 32 34
Zen. Dist.		29 27 26 N.
Declin.		22 21 11 N.
LAT.		51 48 37 N.

708 To compute the 2d Reduction.

Take from Table 50 the 2d Reductions (these will be sensible in the larger hour-angles only), and divide the sum by the whole number of altitudes.

To twice the sum of the three logs. used before (namely, lat., decl., and alt.) add the log. of the mean of the 2d Reductions; the sum is the log. of the 2d Red. required.

Ex. (Ex. 1 preceding)				
$23^m\ 39^s$	2d R.	2″·9	3 logs.	0·0651
18 46		1 ·1		2
		5) 4 ·0		0·1302
		0 ·8	log.	9·9031
	2d RED.	1″·08	log.	0·0333

Subtracting 1″·1 from 7′ 52″·4 gives the lat. omitting decimals, 51° 48′ 38″.

709. When the declin. changes considerably, take the difference between the sums of the Eastern and Western hour-angles, in decimals of an hour; multiply it by the hourly diff. of declin., and divide by the number of altitudes.

When the sun is *approaching* the elevated pole, if the E. sum is the *greater*, *add* this quotient to the Red.; if the *lesser*, *subtract* it. When the sun is *receding* from the elevated pole, the *contrary*.

Ex. 2. May 7th, 1847, lat. by acc. 55° 1′ N., long. 0^h 6^m W., obs. alt. of sun's alternate limbs in the quicksilver, near noon, with the circle; bar. 29·6 inch, therm. 52°.

Times by W.		
11^h	38^m	24^s
11	43	3
11	46	38
11	50	13
11	52	33
11	54	27
11	57	15
11	59	21
0	6	5
0	7	19
0	9	37
0	11	53
0	14	5
0	17	17
0	21	27
0	25	33

During the observation the angle was carried twice quite round the limb, and the final angle registered was

	211°	59′	30″	which
Increased by	1440	0	0	gives
Total Angle Measure	1651	59	30	

The error of watch at noon, as determined by equal alts., was 2^m 3^s·0 *fast* on A. T.

The obs. being made at noon in long. 0^h 6^m, the Green. Date is May 7th, 0^h 6^m in App. Time.

Sun's Decl. at Green. Date, 16° 43′ 1″ N.

To find Approx. Mer. Alt.

Decl.	16°	43′
	90	
	106	43
Lat.	− 55	1
Mer. Alt.	51	42

Sum of Alts.	16) 1651°	59′	30″	
	2) 103	14	58	
Obs. Alt.	51	37	29	
True Alt.	51	36	49	

App. Times	Reductions	2d Reds
11^h 36^m 21^s …	1097·2	2″·9
11 41 0 …	708·3	1 ·2
…………	…………	…………
0 23 30 …	1083·3	2 ·8
Sum	5817·4	16) 9 ·6

To find the Effect of a Change of Declin.

The Sum of the E. H.-ang. is	97^m 30^s
Do. Western do.	94 53
Diff. of E. and W. H.-ang.	2 37
Or	·05^h
Hourly Diff.	41·32
	16) 2·0660
	·13

Effect of Change, Decl. is 0″·13 only.

Do. ÷ 16	363·6	log. 2·5606		0 ·6	log. 9·7781	
Lat.	55° 1′	cos. 9·7584	9·9474			
Decl.	16 43	cos. 9·9812				
Mer. Alt.	51 42	sec. 0·2078	2			
	322·2	log. 2·5080	9·8948		9·8948	
322″ = 5′ 22″			2d Red.	0·5	log. 9·6729	
Alt.	51 36 49					
Mer. Alt.	51 42 11, and Lat. 55° 0′ 50″					

710. The rate of the watch must be allowed for in deducing each hour-angle. In the case of the sun the rate should be found upon A. T., but it is of course near enough for this purpose to employ M. T.

711. An error in the absolute time affects all the hour-angles alike, but it produces the greatest errors in the greater Reductions. The higher the altitude, the greater is the precision required in the time.

When the time is inaccurate the Reductions on one side of the meridian will be too great, and on the other too small; if, therefore, the altitudes P.M. be taken so as to correspond nearly with those A.M. the errors of the Reductions will very nearly compensate.

This distribution of the altitudes, by equalising the number of the hour-angles A.M. and P.M. has also the advantage of neutralising the effect of a change of declination. It is proper, moreover, to multiply the observations near the meridian, in order to weaken, by subdivision, the small errors to which the outer reductions may be liable

712. The effect of *irradiation*, or the increase of the sun's apparent diameter caused by the extreme brightness, and which may amount to 5″ or 6″ (Dr. Robinson on Irradiation, "Mem Roy. Ast. Soc." vol. iv.), is removed by observing both limbs.

[2.] *By a Star or a Planet.*

713 *The Observation* is the same as for the sun, No. 706.

714. *The Computation.* (1.) Having the error of the watch on M.T., find the Greenwich Date. Reduce thereto the Sidereal Time at mean noon, and also the R.A. and decl.; and for a planet, the hor. par.

(2.) Find the hour-angle at each alt. and proceed as for the sun.

When the watch shews Sid. Time, the hour-angles are obtained at once.

715. The stars near the poles, and especially the pole-star, are the best adapted to this observation; because, from the slowness of the motion in altitude, an error of time produces but little error in the Reduction.

716. Errors of altitude, of whatever kind, are removed by employing two bodies on opposite sides of the zenith, and at equal altitudes. A single result, even though obtained with the circle, and without the roof, cannot accordingly be considered definitive when extreme precision is required.

717. Therefore, in the northern hemisphere the best south stars to pair with Polaris are those whose meridian altitudes are about the same as the latitude of the place.

Similarly, in taking Lunars, stars lying at about equal distances, east and west of the moon, should be chosen. *See* No. 861.

III. By Double Altitude of the *Same* Body.

718. Two altitudes, of the same or different celestial bodies, with the interval of time between them, constitute an observation which is called a Double Altitude.* The interval may extend from a few minutes to several hours. *See* Sumner's Method, No. 1009.

719. When a double altitude of the same body is taken, the precepts below will be convenient in directing the method of solution proper for the case.

Also, when a first altitude has been obtained, the observer will find, on referring to the numbers indicated, under the heads *Observation* and *Limits*, instructions how to complete the observation in the manner adapted to the circumstances.

Selection of the Method of Solution.

When *both alts.* are not far from the meridian, on the same side, No. 729; on different sides, No. 731; in a doubtful case, No. 728.

When *one alt.* is near the meridian, No. 737.

When *neither alt.* is near the meridian. If the lat by acc is not greatly in error, No. 746. If it is greatly in error, or if it is proposed to do without it, No. 757.

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* This is the old-established term; it is, however, defective, inasmuch as the word *double* means *twice* the *same*. Since the process involves two altitudes used in combination with one another, the term which would naturally suggest itself is *Combined Altitudes;* we should then have, accordingly, combined altitudes of the same or different bodies, and of long or short intervals. This term, therefore, which is accurate as respects definition, would be clear and descriptive in use. All changes in nomenclature, in this subject, however, must be made [illegible]

1. *Short Double Altitude.*

720. When the time is not known with some degree of precision, the Reduction to the meridian cannot be computed. In such cases recourse must be had to two altitudes separated by a short interval, and not very distant from the meridian.

721. The change of altitude in a small interval of time (No. 696) depends chiefly on the hour-angle or meridian distance, and is nearly the same for a considerable difference of latitude. Although altitudes at sea are always more or less uncertain, yet *difference* of alt. may often be obtained with much precision. If, therefore, the difference of alt. in a small interval of time be measured by an instrument, the hour-angle corresponding may be found by computation. The Reduction to the meridian being then computed for this hour-angle, the latitude is obtained by the method in the last section.

722. The error of the watch is immaterial, but its *rate* should be known nearly enough for measuring the interval without much error.

723. When the altitudes are observed at different places, it is necessary to allow for the ship's run in the interval.

724. Since the lat. by acc. is necessary in computing the Reduction, the work should be repeated when this lat. is found to be very erroneous.

725. *Limits.* When both alts. are taken on the *same* side of the merid., if the outer alt. fall near the limits in Table 47, the Interval should exceed one-fourth of the time of that alt. from noon, and should not be less than 5^m. The observation may be comprised within double the mer. dist. implied in Table 48.

When the alts. are taken on *different* sides, the Interval may vary from 5^m to twice the limit in Table 47.

[1.] *By the Sun.*

726. *The Observation.* Observe an alt.* and note the time. Note the sun's bearing for the purpose of allowing for run. After the proper interval, No. 725, observe the second alt. and bearing, noting the time.

727. *The Computation.*† (1.) Subtract the first of the two times from the second (increased if necessary by 12^h); the rem. is the In-

* Two only, or at most three, altitudes taken in quick succession would be employed in observations with a short interval.

† The first work in which a method occurs of finding the latitude by two altitudes observed near the meridian (but restricted to the *same side*) with an interval of a few minutes, is the "Cours d'Observations Nautiques," by Ducom. The advantage which Admiral W. Owen acquainted me that he had derived from the practice of this method led me to give an account of it in the "United Service Journal," vol. x., together with a rule for adapting it to longer intervals. Soon after the account appeared, Commander Graves, commanding H. M. surveying-vessel Mastiff, was enabled, as he informed me, by this observation, to run direct for Malta before the coming on of a *grecale*, or N.E. gale, to which another of Her Majesty's ships was exposed.

terval. Reduce the declm. for the time of the alt. nearest the mer., No. 579; or to the middle of the interval (that is, to noon) when the alts. are equal.

(2.) Correct the altitudes, No 648 or 649. Also correct the Interval by watch for the rate, if this is very large.

When the sun is rising or falling at both observations, proceed by Case I., No. 729; when rising at one observation, and falling at the other, proceed by Case II., No. 731.

728. When sufficient time is not afforded to perceive the rising or falling of the sun, and when it is not known otherwise whether the altitudes are taken on the same or on different sides of the meridian, proceed thus:

Consider the interval* as a time from noon; and compute the Reduction to it; then,

If the Reduction is *less* than the diff. of alts., the observations are on the *same* side; if the Reduction is the *greater*, they are on *different* sides.

Hence, if the Reduction is *equal* to the diff. of alts., one of the alts. is the meridian altitude.

No great precision is to be expected, as the rules are only approximate. In a doubtful case use either.

729. Case I. The observations on the *same* side of the meridian.

(1.) When the alts. are both A.M. reduce the 1st to the place of the 2d, No. 661; when they are both P.M. reduce the 2d to the place of the 1st, No. 662.† Find the diff. of the alts. and their mean. Correct the diff. alts. and the interval by the Table, p. 223.

(2.) Add together the log. sine of the diff. of alts., the log. cosec. of the interval, the log. sec. of the lat., the log. sec. of the decl., and the log. cos. of the mean alt.: the sum (rejecting tens) is the log. sine of the hour-angle, approximately, at the middle time between the two observations.

(3.) From this time subtract half the interval: the remainder is the time from noon of the altitude nearest the meridian.

(4.) To this time compute the Reduction, which apply to the alt. nearest the meridian, and proceed by No. 700 (5): the result is the latitude at the time and place where the alt. nearest the meridian was observed.‡

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* It is proper to remark here, that the *interval* between two observations of the sun should, in strictness, be measured in *apparent time*, instead of mean time, which is shewn by the watch. To correct the interval on this account, find the change of the Eq of T. for the interval. When the Eq. is *additive*, if it is *increasing*, *subtract* the change; if *decreasing*, *add* it; and the contrary when the Eq is *subtractive*. In the short double alt., however, this correction is insensible, and in long intervals the result is of so inferior a kind that the trifling accuracy gained by this process can rarely be worth the trouble bestowed upon it.

† This reduction is of particular consequence in this observation, because the accuracy of the result depends on that of the difference of altitudes.

‡ This observation, which affords the latitude, the app. time near enough for common purposes, and thence an approximate long. by chronometer, with the azimuth (No. 678), and consequently the variation of the compass, will, it is presumed, be found one of the most useful observations that can be made at sea, especially in high latitudes.

Ex. 1 Oct. 9th, 1878, A.M., lat. acc. 34° 55′ N., long. 61° W., had following obs. height of eye 16 feet, ind. corr. + 3′.

T. by Watch	$11^h\ 12^m\ 52^s$	Alt. ⊙ 46° 47′ 50″	Alt. ⊙ 47° 57′			48° 11′ 0
Ditto	11 43 4	Ind. corr. + 3	+ 3			47 1 50
Interval	30 12	Table 38 + 11	+ 11			95 12 50
Half Int.	15 6	47 1 50	Greater Alt. 48 11		Mean Alt.	47 36 25
					Diff. Alt.	1 9 10
Decl. noon	6° 19′ S.					
Corr. 61° W.	+ 4					
Red. Decl.	6 23 S.					

D. Alts.	1° 9′ 10″	sine	8·3036	Lat. 35°, decl. 6½°, Table 70		0·391
Int.	$30^m\ 12^s$	cosec.	0·8814	$14^m\ 2^s$	sin. sq.	6·972
Lat.	34° 55′	sec.	0·0862	8′	sin.	7·363
Decl.	6 23	sec.	0·0027	Greater Alt	48 11	
Alt. mean	47 36	cos.	9·8289	Mer. Alt.	48 19	
Mid. T.	$29^m\ 8^s$	sine	9·1028		41 41 N.	
½ Int.	15 6			Red. Decl.	6 23 S.	
T. fr. noon	14 2 (of the greater alt.)			LAT.	35 18 N.	

(The Red. for the interval $30^m\ 12^s$ is 37′, which being *less* than 69′, shows the observations to be on the same side of the meridian, if this were doubtful. No. 728.)

The 2d Red. is not worth notice. Repeating the work gives 35° 18′ N.

Ex. 2 Aug. 4th, 1878, lat. acc. 41° 54′ N., long. 39° W., obtained true alt. ⊙ 63° 57′·5; after $11^m\ 12^s$ true alt. 64° 32′·5 (allowing for run). Red. decl. 17° 12′ N.; mean alt. 64° 15′; diff. alts. 35′·0.

	35′ 0″	sin.	8·0078	Lat. 42° N., decl. 17° N.		0·527
	$11^m\ 12^s$	cosec.	1·3111	$23^m\ 40^s$	sin. sq.	7·425
	41° 54′	sec.	0·1282	0° 31′	sin.	7·952
	17 12	sec.	0·0199	64 33		
	64 15	cos.	9·6379	65 4		
Mid. T.	$29^m\ 16^s$	sin.	9·1049	Whence LAT. 42° 8′ N.		
½ Int.	− 5 36					
	23 40			The 2d Red. is not worth notice.		

(The Red. for $11^m\ 12^s$ is 6′·9, which is less than 35′·0. See No. 728.)

Ex. 3. Aug. 11th, 1826, A.M., lat. by acc. 47° N., long. 13° W., obtained true alt. ⊙ 55° 41′·9, bearing S., course E. by N. 7 knots; after $12^m\ 14^s$ obtained true alt. ⊙ 56 37′·9 1st alt. corrected for run, 55° 41′·6, mean alt. 56° 11′, diff. alts. 56′·3, reduced decl. 15° 23′ N Corrections, p. 205, 0.

The mid. time from noon is $1^h\ 0^m\ 14^s$. Reduction 2° 0′, mer. alt. 58° 34½′. LAT. 46° 48½′ N.

The 2d Red. by Table 48, alt. 58°, is 1′ for Red. 1° S., and therefore for Red. 1° 54′ it exceeds 1′.

730. *Degree of Dependance.* The smaller the hour-angle, the less is the effect of error in the D. alts. As the interval may, from its smallness, be assumed to be correctly measured, the value of the result depends chiefly on the difference of alts., and may be estimated by finding the effect of an error of 1′ in the diff. of alts., which is easily done. Divide the middle time by the diff. of alts., both in minutes: the quotient is the number of minutes of error in the time from noon, caused by 1′ error in the diff. of alts.: the case now becomes that of an error in the Reduction itself, No. 704.*

Ex. In Ex. 3, above, 60^m divided by 56′ gives $1^m·1$, which is the error in the time from noon, supposing 56′ to be 1′ in error. Now, by inspecting Table 47, lat. 47° and decl. 15°, (*same* name) give 27^m as the limit, or time from noon at which 1^m error of time causes 2

* When the lat. is found to have been very erroneous, repetition is very easily effected, as the sec. lat. is the only log. in 729 (2) that changes.

error in the reduction: hence $1^m\cdot 1$ error at 1^h from noon will cause about 5′ error in the Reduction, and therefore in the latitude.

This example is not an eligible one, since 12^m is only 1-5th of 1^h, instead of being not less than 1-4th. See No. 725.

731. Case II. Observations on *different* sides of the meridian.

(1.) Reduce the alts. to the place of the alt. nearest the meridian, No. 661 or 662. Find the diff. of alts.; correct it and the half interval, when necessary, by the Table, p. 223.

(2.) To the arith. comp. of the log. in Tab. 70 add the log. sine of the diff. of alts. and the log. cosec. of half the interval: the sum is the log. sine of half the diff. of the times from noon corresponding to the two altitudes.

(3.) Subtract this half diff. from the half interval: the remainder is the time from noon (or merid. dist.) of the alt. nearest the meridian.

(4.) Compute the Reduction to this time, and apply it to the alt. nearest the meridian, and proceed as directed, No. 700. The result is the latitude at the time and place where the alt. nearest the meridian was observed.

Ex 1. April 3d, 18·8, lat. by acc. 46° 2′ N., long. 17° W., the true alts. of the sun to the southward, reduced to last place of observation as below. Red. decl. 5° 23′ N.

Times by Watch	$2^h\ 0^m\ 54^s$		true alt.	49° 10′ 30″ A.M., or rising.
	2 35 52			49 23 53 P.M., or falling.
Interval	34 58		diff. alt.	13 23

Lat. 46°, decl. 5°, ar. co. log.	9·676		Lat. 46°, decl. 5°,	log.	0·324
Diff. alts. 13′ 23″	sin. 7·590		$11^m\ 56^s$	sin. sq.	6·831
Half. int. $17^m 29^s$	cosec. 1·118		Red. 0° 5′	sin.	7·155
Half. diff. −5 33	sin. 8·384		Gr. alt. 49 24		
T. fr. noon 11 56 (of greater alt.)			Mer. alt. 49 29		
			which gives the Lat. 45° 54′ N.		

Ex. 2. H.M.S. Leven, Aug. 10th, 1826, **lat. by acc.** 46° N., long. 15° W., obtained true alt. ☉ 59° 57′·2; after $28^m\ 42^s$ true alt. 59° 20′·5, the ship having little or no way. Reduced decl. at 1st alt. 15° 40′ N.

46° and 16°, ar. co. log.			9·573
Diff. alts.	36′ 42″	sin.	8·028
Half int.	$14^m\ 21^s$	cosec.	1·204
Half diff.	14 39	sin.	8·805

This small excess of the computed ½ diff. over the ½ interval (which should be the greater) is due to the error of the method itself, which becomes apparent in a long interval, and it shews that the alt. 59° 57′·2 is very nearly the mer. alt. This gives the Lat. 45° 43′ N.

Ex. 3. Dec. 23d, 1825, lat. by acc. 8° S., observed true alts. ☉ 74° 26′ A.M. and 74° 16′ P.M., with the interval $36^m\ 37^s$ Reduced decl. 23° 27′ S.

	Ar. co. log.	9·168				0·832
	10′ sin.	7·464			$17^m\ 4^s$	7·142
$18^m\ 18^s$	cosec.	1·098		Red. 0° 32′	sin.	7·974
−1 14	sin.	7·730		−1	(Table 48.)	
17 4				74 26		
				75 57		

The Lat. is 8° 24′ S. This Ex. is far without the limits, Table 47.

Ex. 4. Aug. 9th, 1826, **lat. by acc.** 45° N., long. 15° W., A.M., obtained true alt. ☉ 60° 29′·5. After $52^m\ 27^s$ obtained true alt. 60° 30′. The 1st alt. reduced for 1′ northing made good in the interval is 60° 28′·5.

The diff. alts. 1′·5 and a half interval $26^m\ 16^s$ give half diff. 19^s; the Red. is 31′, and mer. alt 61° 1′, which, with reduced decl. 15° 57′ N., give Lat. 44° 56′ N.

732. When the alts. are equal, the half interval is the time from noon.

733. *Degree of Dependance.* It would not be easy to give a concise rule for this in long intervals. The rule No. 730 applies very nearly in short and moderate intervals, using, instead of the "middle time," the time from noon of the alt. nearest the meridian.

[2.] *Short Double Altitude of a Star.*

734. Increase the interval by 1^s for every 6^m. Take the decl. from the Nautical Almanac, or Table 63. In other respects proceed as for the sun.

[3.] *Short Double Altitude of a Planet.*

735. Find the Greenwich Date for the middle of the interval, and reduce the decl. Find the daily variation of R.A., and deduce by Table 21 the change of R.A. for the interval. When the R.A. is *increasing*, *subtract* this change from the interval; when *decreasing*, *add* it. Increase the interval by the acceleration upon it. In other respects proceed as for the sun.

As the R.A. and decl. of a planet sometimes change very slowly, much of the above labour is not always necessary: particular rules for all such cases would, however, be superfluous.

[4.] *By the Moon.*

736. Find the Greenwich Date as nearly as possible at each observation, and compute the R.A. *Subtract* from the interval the change of R.A., and add to it the acceleration. Reduce the decl. to the middle of the interval, as also the hor. par. and semid. In other respects proceed as for the sun.

As a proper allowance for a considerable change of declination would complicate the rule, the moon can be employed satisfactorily in this observation only in cases of very short intervals, and when her declination changes slowly.

2. *Double Altitude, one Altitude being near the Meridian.*

737. When one of two altitudes is taken near the meridian, and the other when the body has a large azimuth, the *outer* hour-angle (or that corresponding to the altitude furthest from the meridian) may be computed nearly (No. 614), since it will not be much affected by an error in the latitude by account.* The difference of the hour-angles being afforded by the measured interval of time, the other, or *inner* hour-angle, is found; and the Reduction being computed thereto, the mer. alt. is deduced. See Nos. 722 and 723.

738. *Limits.* The inner alt. must be within the limits in Table 47, and the outer angle should be as nearly E. or W. as possible.

When the outer bearing is not near E. or W., the outer hour-

* The *latitude by account*, in cases in which the ship's change of place is considerable, refers of course, to the place to which the alts. are reduced.

angle may be sensibly affected by the error of the lat. by acc.; and if the inner hour-angle be not very small, the work may require to be repeated.

[1.] *By the Sun.*

739. *The Observation.* Observe the sun's alt., noting the time and the bearing. After a sufficient interval (No. 738) observe the second altitude. See note to No. 726.

740. *The Computation.* (1.) Reduce the decl. at both observations, either by Table 19, No. 579, or by the Green. Date, No. 580, and find the outer pol. dist.

(2.) Correct the interval for the rate of the watch when large.

Correct the altitudes.

When both observations are A.M., reduce the 1st alt. to the 2d place of observation, No. 661. When both observations are P.M., reduce the 2d alt. to the place of the 1st, No 662. When one observation is A.M., and the other P.M., reduce the alts. to the place of the alt. nearest the meridian.

(3.) With the outer alt., the lat. by acc., and the outer pol. dist., compute the hour-angle, No. 614.

(4.) Take the diff. between this hour-angle and the interval: this is the *inner* hour-angle.

(5.) With this hour-angle compute the Reduction to the meridian and apply it (No. 700 (4) and (5)), to the alt. nearest the merid. The decl. which is to be applied to the mer. zen. dist. is that reduced to the time of the alt. nearest the meridian.

Ex. 1. July 23d, 1878, lat. by acc. 54° 57′ N., long. 1° 25′ W., at about $7^h 0^m$ A.M. obs alt. ☉ 24° 30, bearing E. by S. by compass; $4^h 30^m 12^s$ afterwards obs. alt. ☉ 54° 26, course S.S.E., rate 4·5 knots; ind. corr. +2′, eye 18 feet: required the Lat. at 2d obs.

From S.S.E. to E. by S., or 5 pts., and dist. in interval 20′·3 give corr. of alt. +11.

Decl. 23d at noon		20° 4′ N.			
Long. 1°	−0′				
$5^h 0^m$	+3	+3			
1st Red. Decl.		20 7			
Int. $4^h 30^m$		−2			
2d Red Decl.		20 5			
Obs Alt. 24° 30′,			Obs. Alt. 54° 26′		
Ind. cor.	+2′	+12	+2′	+13	
Tab. 38	+10		+11		
		24 42	2d Alt.	54 39	
Corr. for run		+11			
1st Alt.		24 53			
(The Alt. nearest Mer. is here the 2d.)					

Alt.	24° 53		
Lat.	54 57	sec.	0·24086
P. Dist	69 53	cosec.	0·02774
	74 51	cos.	9·41722
	49 58	sine	9·88404
Hour-an.	$5^h 0^m 14^s$	sin sq	9·56946
Interval	4 30 12		
Inn. H.-an.	30 2	sin. sq.	7·6 2
Lat. 55	Decl. 20	(*same name*)	0·271
Red.	+28	sin.	7·906
	54 39		
Mer. Alt.	55 7		
Zen Dist.	34 53 N.		
Decl.	20 5 N.		
Lat.	54 58 N.		

Ex. 2 April 3d, 1878 lat. by acc 46° 7′ N., long. 14° W. at about $8^h 10^m$ A.M. obs. alt. ☉ 26° 10′, sun S E.; $3^h 26^m 35^s$ afterwards (corrected for rate) obs. alt. ☉ 49° 8′ to the southward; course W.; rate 6·8 knots: index −3′: eye 16 feet: find Lat. at 2d obs.

From W. to S E. is 12 pts.; 4 pts. and dist. 23·1 give corr. of 1st alt. −16′. The 1st red decl. 5° 20′ N.; the 2d, 5° 23 N.; the 1st alt. (corr. for run), 26° 1′; 2d alt. 49° 16′.

Alt. 26° 1′, lat. 46° 7′, and P. dist. 84° 40′, give hour-angle $3^h\ 49^m\ 41^s$, hence inn. hour-angle $23^m\ 6^s$ and Red. + 18′, LAT. 45° 49′ N.

Ex. 3. Dec. 30th, 1825, lat. by acc. 8° S., long. 6° W., at about $4^h\ 8^m\ 16^s$ by watch, the mean of 3 alts. ☉ 49° 9′·4, bearing S. 44° E. magnetic, course W.N.W. 6 knots; at $6^h\ 18^m\ 52^s$ mean of 2 alts. ☉ 73° 39′, the watch losing $4^s·5$ an hour on the chron., and the chron. gaining $6^s·6$ a-day; height of eye, 16 feet; ind. corr. + 1′; reduced decl. 23° 11 S.

In the interval, $2^h\frac{1}{3}$, the chron. gained about 1-10th of $6^s·6$ or $0^s·7$, and the watch lost $10^s·1$ on the chron.; the measured interval must therefore be increased by $9^s·4$, and becomes $2^h\ 10^m\ 45^s$.

From W.N.W. to S. 44° E. is 156°; course 24° and dist. 13 miles give D. Lat. 11′·9, to be *subtracted* from the 1st alt.

Alt. 49° 10′, lat. 8° 1′, and pol. dist. 66° 49′, give *outer* hour-angle $2^h\ 38^m\ 16^s$; the diff. of this and $2^h\ 10^m\ 45^s$, or $27^m\ 31^s$, is the *inner* hour-angle, which, with alt. 73° 52′, reduction 1° 27′, and 2d reduction 4′, give LAT. 8° 26′ S.

[2.] *Double Altitude of a Star, one Alt. near the Meridian.*

741. Increase the interval by 10^s for each hour. Take the decl. from the Nautical Almanac, or from Table 63. In other respects proceed as for the sun.

[3.] *Double Altitude of a Planet, one Alt. near the Meridian.*

742. Find the Green. Date at each observation, and reduce to it the R.A. and decl. Apply the change of R.A. to the interval, as directed No. 735, and add to the interval the acceleration upon it Proceed as for the sun.

[4.] *Double Altitude of the Moon, one Alt. near the Meridian.*

743. Proceed by No. 736 as far as adding the acceleration. Reduce the decl. to each Gr. Date, and the hor. par. and semid. to that nearest the meridian. Proceed as for the sun.

744. The moon may be advantageously employed for this purpose when the Greenwich Time can be nearly ascertained, and in all cases when near her maximum declination, because her polar distance may then be very nearly computed.

745. *Degree of Dependance.* The error of the inner hour-angle is the same as that of the outer one, which, when the body is near E. or W., will be very small, even when the lat. by acc. is considerably in error.

3. *Double Altitude, neither Altitude being near the Meridian.*

746. When neither altitude is near the meridian, the computation is different from those hitherto given, of which the object is to find the meridian altitude.

We shall give, 1st, an *approximate* method, the object of which is to find the *correction of the lat. by acc.*; and, 2d, the *rigorous* method, the object of which is to find the *latitude itself* directly, both in Ivory's form (suited to the case in which the decl. is the same at both observations) and in a general form.

747. The principle of the approximate method will easily be

understood. Suppose the time* to be computed at each observation, then, if the interval between these computed times agrees with that actually shewn by a good watch, the latitude by acc. (which is an element of the calculation of the time) is obviously correct, but if on the other hand, the computed interval does not agree with the interval by the watch, the disagreement indicates an error in the latitude by acc.,† the *amount* of which is to be computed.

748. When the correction of the lat. by acc. exceeds 10′ or 15′, it may, generally, be advisable to repeat the computation; but when it is less than 4′ or 5′ it may be considered rather as confirming the lat. by acc. within this limit, than as correcting it by so small a quantity.

See, also, Nos. 722 and 723, which apply to this observation.

749. *Limits.* An observation that is usually a substitute for a better, which the state of the weather has prevented, or seems likely to prevent, from being obtained, must be taken when it offers itself; but when there is a choice of observations, the limits are as follows:—

(1.) When the observations are on the *same* side of the meridian, the difference of bearing at the two observations should exceed the lesser true bearing.

(2.) When on *different* sides of the meridian, the *supplement* of the diff. of bearing should exceed the lesser true bearing.

The diff. of bearing should, when possible, be 90°.

750. The simplest case in computation. This will of course be selected when the weather allows a choice of observations.

In N. lat. both altitudes are to be taken to the southward of E. or W. (or the prime vertical); in S. lat. both are to be taken to the northward of E. or W.

When the lat. and decl. are of *contrary* names, the simple case is the only one that offers itself, and therefore applies to the sun during the six months which include the winter. When the lat. and decl. are of the *same* name, the hour-angle at each observation is to be *less* than the hour-angle in Table 29, or the altitude is to be *greater* than the alt. in that Table.

[1.] *Double Altitude of the Sun.*

751. *The Observation.* Take the alt. (see note to No. 726), noting the time, and the true bearing. After the proper change of bearing take the other altitude, noting the time.

As waiting for the proper change of bearing may risk the loss of the 2d alt. it will be prudent to provide an altitude earlier to serve in case of accident.

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* As the hour-angles only are here concerned, the consideration of Time, as found by observation, will present no difficulty to a learner.

† Admiral Sir Edward Owen informed me, that when in the North Sea he made constant use of the method of finding the lat. by the discrepancy of the computed times, as he found it much more convenient in practice, in cases where it was necessary to profit by every opportunity of observation, than any solution of the Double Altitude as a question of latitude only. In Lynn's Tables the same problem is worked by trial and error. In Capt. Owen's journals the observation, solved upon the same principle as that here adopted, constantly occurs.

Note at each observation whether the sun is to the northward or to the southward of E. and W.

An example will shew how to select the simple case.

Ex. 1. Oct. 3d, lat. 25° N. The lat. is N. and declin. south, and it is the simple case.

Ex. 2. Sept. 1st, lat 40° N. The decl. is 8° N.; hence (Table 29) the 1st alt. must be taken after $6^h\ 39^m$ A.M. (which is the suppl. to 12^h of the hour-angle $5^h\ 21^m$), and the 2d before $5^h\ 21^m$ P.M. (A. T.); or each alt. of the centre must exceed 12°·5.

752. *The Computation.* The *approximate* method.*

If the difference of azimuth is not considerable this method should not be employed. In low lats. it will accordingly be less serviceable than in high latitudes The proper limits for the solution will be seen on inspecting Table 71; cases outside the limits should be rejected, and those bordering on them employed with caution, especially if the error of the latitude by account is large.

(1.) Find the Green. Date at the first observation. Reduce the declin. to each time of observation. For the sun, it is immaterial whether app. time or mean time be used. In general at sea app. time will be preferable, because when the observation confirms the lat. by acc. the apparent time at ship is determined. Find the polar distances (No. 443).

(2.) If the rate of the watch is large, correct the interval for it. Correct the alts. and reduce the 1st alt. to the 2d place of observation.† No 661.

(3.) With the alt., lat. by acc., and pol. dist., compute the hour-angle at each observation, No. 614.

(4.) When the observations are on the *same* side of the meridian, take the *difference* of the hour-angles; when on *opposite* sides, their *sum*. If this diff. or sum agrees with the interval by watch within 10^s, or even 20^s, provided the difference of azimuth is considerable, the lat. is confirmed, and the time is also obtained, nearly enough in the open sea. If they do not agree, proceed thus:—

(5.) In N lat. if the body at both observations is to the *south*ward of E. or W., it is the simple case (No. 750); if the body is to the *north*ward of E. or W., mark such hour-angle V.

In S. lat., if the body at both observations is to the *north*ward of

* This method, besides affording the time when the lat. by acc. is not very erroneous, employs the azimuths, which in practice is a considerable advantage, since the azimuth is the means of determining the degree of dependance of the lat. by double altitude.

† As some misunderstanding has prevailed upon the necessity of correcting the *interval of time* for the *change of longitude* of the ship, the following illustration, which was given in answer to the question, in the Nautical Magazine, 1840, is here inserted:—

Suppose at a place A, at 10 A.M., the sun's alt. is observed 13° 18', and $3^h\ 40^m$ afterwards a 2d alt. is observed. These two alts. with the interval $3^h\ 40^m$ afford the latitude of A.

Again, suppose at a place B an observer had obtained the alt. at 10 A.M, or exactly at the same instant the observer at A took his 1st alt., and $3^h\ 40^m$ afterwards he obtains his 2d alt. 14° 15'. These two alts with the interval $3^h\ 40^m$ afford the lat. of B. Now suppose a ship had left A at 10 A.M., having obtained the 1st alt 13° 18', and at the end of $3^h\ 40^m$ she arrives at B, where she obtains her 2d alt 14° 15'; then she has the given interval $3^h\ 40^m$ with the 2d alt. 14° 15'; and it is clear that by reducing the 1st alt. observed at A, or 13° 18', to what it would have been if observed at B (that is, in other words, correcting the 1st alt. for the mere *change of place*), she has precisely the elements for determining the lat. of B, which is required.

Thus, when the interval is measured by a watch, no correction for longitude appears.

E. or W., it is the simple case; if the body is to the *south*ward of E. or W., mark such hour-angle V.

If the bearing has not been observed, or if it is doubtful, look in Table 29; then, if the computed hour-angle *exceeds* the hour-angle in the Table, mark it V; if the comp. hour-angle is the *lesser*, use no mark. If both hour-angles are less than in Table 29, it is the simple case.

(6.) For the Correction of the Lat. Compute the azimuths at each observation, No. 676.

(7.) When the observations are on the *same* side, both of the meridian and prime vertical, enter Table 71, Part I. with the azimuths. When the observations are on *different* sides, either of the meridian or prime vertical, enter Part II.

To the log. from Table 71 add the log. sec. of the lat. by acc., and the prop. log. of the error of the interval; the sum (rejecting tens) is the prop. log. of the correction of the lat. by acc.

(8.) In the simple case (No. 750), apply the correction to the lat. by acc. according to the following directions:—

Observations on the *same* side of the Meridian		Observations on *different* sides of the Meridian	
The Computed Interval being		The Computed Interval being	
the greater	the lesser	the greater	the lesser
sub.	*add*	*add*	*sub.*

In the case in which *one* or *both* hour-angles are marked V (No. (5) above), apply the correction according to the directions in the next Table.

	Observations on the *same* side of the Meridian				Observations on *different* sides of the Meridian			
	The Computed Interval being				The Computed Interval being			
	the *greater*		the *lesser*		the *greater*		the *lesser*	
Both observations on the *same* side of the Prime Vertical, and *both* marked V.	The *greater* Hour ∠ being with the		The *greater* Hour ∠ being with the					
	greater Azim.	*lesser* Azim.	*greater* Azim.	*lesser* Azim.				
	add	*sub.*	*sub.*	*add*	*sub.*		*add*	
Observations on *different* sides of the Prime Vertical, or *one* marked V.	The Hour ∠ V being with the		The Hour ∠ V being with the		The Hour ∠ V being with the		The Hour ∠ V being with the	
	greater Azim.	*lesser* Azim.	*greater* Azim.	*lesser* Azim.	*greater* Azim.	*lesser* Azim.	*greater* Azim.	*lesser* Azim.
	sub.	*add*	*add*	*sub.*	*add*	*sub.*	*sub.*	*add*

Note. This second Table, which contains the remaining fourteen out of eighteen cases, may appear complicated in its general aspect. It is, however, easy of reference when the case is proposed. For ex.:—

1. Suppose the observations to be on *different* sides of the meridian; of this point, with a long interval, there can never be a doubt. Again,

2. Let them be on *different* sides of the prime vertical, of which there can rarely be any doubt.

3. Let the computed interval be the *greater*.

Then the precept *add* or *sub.* depends on the condition that the hour-angle marked V is with the *greater* or with the *lesser* azimuth.

Ex. 1. (Observ. *same* side both of Mer. and Pr. Vert.) May 20th, 1878, lat. by acc 40° 12′ N., long. 62° W., at about 8h 0m 0s A.M., obs. alt. ☉ 35° 32′, bearing E. by S; at 11h 8m 32s A.M., obs. alt. ☉ 66° 58′; index −3′, eye 16 feet: course during interval S.E. ½E.; rate 4 knots: required the Lat. at 2d observation.

From S.E. ½E. to E. by S., or 2½ pts. and dist. 12·4, corr. of 1st Alt. +11′.

Decl noon, 20th,	20° 1′ N.	Alt. ☉	35 32′	Alt. ☉	66° 58′
4h −2′ } 62 W. +2 }	0	Ind. −3′ } Table 38 +11 }	+ 8	−3′ } +12 }	+ 9
1st Red. Decl.	20 1		35 40	2d True Alt.	67 7
3h 9m	+ 2	Corr. run	+ 11		
2d Red. Decl.	20 3	1st True Alt.	35 51		

1st Hour-angle.				2d Hour-angle.			
Alt.	35° 51′			Alt.	67° 7′		
Lat.	40 12	sec.	0·11702	Lat.	40 12	sec.	0·11702
P. Dist.	69 59	cosec.	0·02706	P. Dist.	69 57	cosec.	0·02715
	146 2				177 16		
	73 1	cos.	9·46552		88 38	cos.	8·37750
	37 10	sin.	9·78113		21 31	sin.	9·56440
1st H.-angle	3h 57m 49s	sin. sq.	9·39073	2d H.-angle	0h 50m 43s	sin. sq.	8·08607
				1st ditto	3 57 49		
				Comput. Int.	3 7 6	(the *lesser*)	
				Interval	3 8 32		
				Error	1 26		

1st Azimuth.				2d Azimuth.			
	3h 57m 48s	sine	9·9351		0h 50m 43s	sine	9·3414
Decl.	20° 1	cos.	9·9729	Decl.	20° 3	cos.	9·9728
Alt.	35 51	sec.	0·0912	Alt.	67 7	sec.	0·4100
Azim.	87°	sin.	9·9992	Azim.	32°	sin.	9·7242

Correction of the Latitude.

Table 71, Part I., 32° and 87°		9·014
	Lat. sec. (above)	0·117
	1m 26s pro. log.	2·097
Corr. of Lat. 11′	Pro. log.	1·230

The lat. being N., and both observations to the southward, it is the simple case, the obs. being on the same side of the merid. and the computed interval the *lesser*, 11′ is to be added to 40° 12′, which gives Lat. 40° 23′ N.

Ex. 2. (*Different* sides of Mer.) Oct. 16th, 1878, lat. by acc. 41° 22′ S., long. 150° E., at about 10h 45m A.M. obs. alt. ☉ 53° 2′ 20″, bearing by compass S.E. by S.; time by chron. 6h 29m 19s; at 10h 29m 6s by same chron. obs. alt. ☉ 41° 1′ 10″, ind. corr. −3′ 20″, height of eye 14 feet; chron. *gaining* 12s·2 daily. Course S.E. by S.; rate 6 knots.

The course being exactly towards the sun, the run in 4h gives 24 to be *added* to 1st alt. The pol. dists, 81° 14′ and 81° 10′; 1st alt. 53° 35′; 2d, 41° 9.

Alt.	53° 35		
Lat.	41 22	sec.	0·12465
P Dist.	81 14	cosec.	0·00508
	176 11		
	88 5	cos.	8·52434
	34 30	sine	9·75313
1st H.-angle	1h 13m 34s	sin. sq.	8·40720

Alt.	41° 9′		
Lat.	41 22	sec.	0·12465
P. Dist.	81 10	cosec.	0·00518
	163 41		
	81 50	cos.	9·15245
	40 41	sine	9·8141
3d H.-angle	2h 45m 33s	sin. sq.	9·0964
1st do.	1 13 34		
	3 59 7 (*the lesser*)		
Interval	3 59 47		
	0 0 40		

1st Azimuth.

	1h 13m 34s	sine	9·499
Decl.	8 46′	cos.	9·995
Alt.	53 35	sec.	0·226
Azim	31°	sin.	9·720

2d Azimuth.

	2h 45m 34s	sine	9·820
Decl.	8° 50′	cos.	9·995
Alt.	41 9	sec.	0·123
Azim.	60°	sin.	9·938

Correction of the Latitude.

Table 71, Part II., 31° and 60°	9·174
Lat. sec. (above)	0·125
0m 40s pro log.	2·431
3′ pro. log.	1·730

The obs. on *different* sides of meridian and the computed interval the *lesser*, 3′ has to be subtracted from 41° 22′, which gives Lat. 41° 19′ S.

Ex. 3. (*different* sides of the pr. vert.) Feb. 19th, 1878, lat. by acc. 52° 55′ S., long. 11° E., at 1h 40m P.M. obs. alt. ☉ 43° 53′, bearing S.W. by S ; at 5h 39m 5s P.M. obs. alt. ☉ 11° 55′. Course in int. N E. by N., 3·5 knots an hour ; height of eye 16 feet : required the LATITUDE at 2d observation.

1st Alt. (run allowed for) 43° 50′, 2d Alt. 12° 3′ ; 1st Pol. Dist. 78° 48′, 2d Pol. Dist. 78° 51′ ; 1st Hour-angle 1h 38m 46s, Az. 35° ; 2d Hour angle 5h 38m 57s, V. Az. 87° ; corr. of lat. 7′ to be subtracted, because the obs. are on the same side of mer., the computed int. *greater*, obs. on *different* sides of pr. vert., and the hour-angle V with greater azimuth. LAT. 52° 48′ S.

[2.] ***Double Altitude of a Star.***

753. This is the same as for the sun, except that the interval by watch must be *increased* by 10s an hour.

[3.] *Double Altitude of a Planet.*

754. Find the Green. Date at each obs., and reduce thereto the R.A. and decl. Apply the change of R.A. to the interval, as directed No. 735, and add to the interval the Acceleration upon it. In other respects proceed as for the sun.

[4.] *Double Altitude of the Moon.*

755. Find the Green. Date at each observation, and reduce the R.A. and decl. *Subtract* the change of R.A. from the interval, and add to the interval the Acceleration upon it. In other respects proceed as for the sun.

756. For the *Degree of Dependance*, see No. 771.

4. *Ivory's Solution, for the same Body.*

757. Though this method applies, strictly, to a body which does not change its declination, yet it answers well enough, in common

practice, with the sun, by employing a mean between the pol. dists. proper to each observation. The same is true of the moon when near her greatest declination, N. or S., since at that period she changes her decl. about 1′ only in 6 hours.

(1.) With the sun, the moon, or a planet, find the Greenwich Date for the middle time between the observations, and reduce the decl. thereto.

Find the pol. dist. by means of the lat. by acc., N. or S.

Correct the altitudes, and reduce them to the 2d place of observation.

Find the polar angle. For the sun, this is the interval in app. time; or mean time, as shewn by the watch, is near enough. For a star, see No. 734. For a planet, see No. 735. For the moon, see No. 736. Take half the interval, and find half the sum and half the difference of the altitudes.

Note.—When the interval is rather small, more care is required in the work, which may then be carried to quarter minutes in Table 68, at sight.

(2.) For Arc 1. To the log. sine of the half interval add the log. cos. of the decl.: the sum is the log. sine of arc 1.

(3.) For Arc 2. Take the ar. comp. of the log. sine found, and add to it the log. cos. of the half sum of the alts., and the log. sine of their half diff.: the sum is the log. sine of arc 2.

(4.) For Arc 3. To the log. sine of the decl. add the log. sec. of arc 1: the sum is the log. cos. of arc 3.

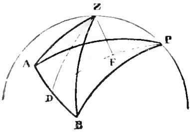
When the lat. and decl. are of contrary names, or the pol. dist. exceeds 90°, take the suppl. of this arc.

(5.) For Arc 4. Add together the log. sec. of arc 1, the log. sine of the half sum of the alts., the log. cos. of their half diff., and the log. sec. of arc 2: the sum is the log. cos. of arc 4.

(6.) For Arc 5. This is the diff. or sum of arcs 3 and 4.* When the observations are on *different* sides of the meridian; if the pol. dist. is *greater* than the colat. take the *diff.*; if *less*, the *sum*.

When the observations are on the *same* side of the merid., when the pol. dist. *exceeds* the colat., take the diff. When the pol. dist. is *equal* to or *less* than the colat., take out the log. sine of the lat. by acc.; then add together the log. sines of the decl. and mean of the

* This step is so near the end of the operation, that the computer may content himself with trying whether the sum or diff. gives the result in lat. nearest to the lat. by acc., as in all eligible cases the two results will differ greatly.



A and B are the places of the body at the two observations; P A, P B the polar distances; Z A, Z B the zen. dists.; A P B the polar angle or interval. P D is drawn perp. to A B, and dividing A P B into two equal parts; Z F is perp. to P D.

Then, Arc 1 is A D; Arc 2 is Z F; Arc 3 is P D. As P D is usually greater than A D, from which it is determined, if a small error occurs in A D. P D will be in error still more. Arc 4 is D F; Arc 5 is P F. P F here is P D − D F; but when the pol. dist. is much less than P Z, F may fall beyond D on P D produced, and then P F = P D + D F. The colat. P Z is then found from P F and Z F.

alts. (already employed). If this last sum is *less* than the sin. of the lat., take the *diff.*; if *greater*, the *sum*. One place in the logs. is enough, since, if the distinction is not strongly marked, the case should be rejected.

(7.) For the Latitude. To the log. sec. of arc 5 add the log sec of arc 2; the sum is the log. cosec. of the latitude.

Note.—To save reopening Table 68 at the same place, logs. taken out at the same opening, or repeated, are marked with the same letters.

Ex. 1. (Obs. *same* side.) Lat. by acc. 10° S, long. 7° E.; true alts. of the sun, 58° 40′, and 63° 0 reduced to the same place; interval, 32^m 54^s: required the Latitude.

Red. of Decl. in the Form, Ex. 1, p. 261.

Red. Decl.	14° 24′ N.
Pol. Dist.	104 24

Correction of Alts. in the Form, Ex. 1, p. 266, then,

1st Alt.	58° 40		
2d	63 0		
Sum	121 40	Half Sum	60° 50
Diff.	4 20	Half Diff.	2 10

Int.	32^m 54^s						
Half	16 27	sin.	8·85605				
Decl.	14° 24′	cos.	9·98614 (*a*)	....		sin.	9·39566 (*a*)
Arc 1	3 59	sin.	8·84219 (*b*)	....		sec.	0·00105 (*b*)
				(Suppl.)	75° 34′	cos.	9·39671
				Arc 3	104 26		
		Ar. co.	1·15781			sec. Arc 1 (rep.)	0·00105 (*b*)
Half Sum	60° 50′	cos.	9·68784 (*c*)	....	...	sin.	9·94112 (*c*)
Half Diff.	2 10	sin.	8·57757 (*d*)	....	...	cos.	9·99969 (*a*)
Arc 2	15 22	sin.	9·42322 (*e*)			sec. Arc 2	0·01581 (*e*)
				Arc 4	24 53	cos.	9·95767
				Arc 5	79 33	sec.	0·74142
Criterion for *Sum* or *Diff.* of Arcs 3 and 4.						Arc 2, sec. (rep.)	0·01581 (*e*)
Pol. Dist. *exceeds* colat.-*diff.*				LAT.	10° 4′	cosec.	0·75723

Ex. 2. (*same* side mer.) Lat by acc. 43° 10′ N.; alts. of Capella, reduced to the same place, 22° 58′ and 56° 14′; interval by chronometer, 3^h 34^m 17^s: required the Lat.

Interval red. 3^h 34^m 53^s; decl. 45° 50′ N.; arc 3, 40° 55′. Criterion, sin. lat. 9·8; sum of sines of decl. and mean alt. 9·6; take the *diff.* of arcs 3 and 4. LAT. 43° 29′ N.

Ex. 3. (obs. *different* sides.) Lat. by acc. 10° N.; alts. of Castor, 63° 16′ and 46° 12′; interval by a watch, 3^h 55^m 25^s; decl. 32° 14′ N.: required the Lat.

Arc 1, 24° 33½′; Arc 2, 11° 54′; Arc 3, 54° 5½′; Arc 5, 78° 58′. LAT. 10° 47½′ N.

758. (1.) When the alts. are equal, this method is peculiarly convenient.

Compute arcs 1 and 3, as above. Arc 2 is 0.

For Arc 4. Add together the log. sine of the alt. and the log. sec. of arc 1: the sum is the log. cos. of arc 4.

When the pol. dist. exceeds the colat., the diff. of arcs 3 and 4 is the colat.; otherwise their sum.

Ex. Equal alts. 46° 51′; pol. dist. 66° 33; interval, 4^h 37^m 50^s. LAT. by acc. 60°. Arc 1, 31° 30¼′; Arc 3, 62° 10¾′; Arc 4, 31° 9½′. LAT. 58° 59′.

(2.) When the declin. is 0, the half int. is arc 1, and arc 3 is 90°.

Ex. Lat. by acc. 60° N., decl. 0, int. 2^h 0^m 0^s; true alts. 28° 53′ and 20° 42′. Arc 1 is 15° 0′; Arc 2, 14° 29½′; Arc 5, 26° 34′. LAT. 59° 59½′ N.

Note.—If the time also is required from the observation, with the outer alt., lat found, and pol dist. (red. to time of outer alt.), find the hour angle, No. 614, and see No. 780 (4), p. 279. The sum of log sec. lat. and log. sin. arc 2 is log. sin. mid. time between the obs.

IV By Double Altitude of *Different* Bodies.

759. The forms of solution described in Nos. 737 and 747 for the cases of two altitudes of the same celestial body apply to the altitudes of different bodies, the difference of their right ascensions supplying in part, or entirely, the place of the measured interval.

Since the value of this observation, like the former, depends upon the difference of azimuth, the two bodies may often be so selected as to afford the best possible result under the circumstances, while in the case of a single body the necessary conditions are not, generally, matter of choice. Hence this method may be practised with equal convenience in all latitudes.

This observation is particularly convenient in the case of two stars, because, as the right ascensions of the stars change very slowly no reference to the absolute time is necessary.

760. When the two observations can be obtained at nearly the same time, this method has the advantage of being independent of the rate of the watch, and also of the errors of the ship's run; but when an interval elapses between the observations, allowance must be made both for the rate and the run.

1. *One of the Altitudes (of Two Bodies) being near the Meridian.*

761. *Limits.* These are the same as those given in No. 745. It must be remarked, that the rules for the limits apply to the bearings at the time the bodies are actually observed, whether there be an interval or not. For ex., if the sun be observed S.S.E., and the moon E. by S., the case is a good one; but if the observation of the moon were delayed till she bore S.E., the case would not be good.

762. *The Observation.* Take the alt. of the outer body, which should be observed as nearly E. or W. as possible. Then observe the alt. of the inner one; lastly, that of the outer one again, noting the times of each alt.

763. *The Computation.* (1.) For the sun, moon, or a planet. Find the Green. Date, and reduce thereto the R.A. and declination; and for the moon, her hor. par. and semid.

For a star. Take the R.A. and decl. from the Nautical Almanac, or from Table 63.

Call the diff. of R.A., or its suppl., *the polar angle.*

(2.) Reduce the alts. to the same instant, and correct them.

(3.) With the outer alt. and pol. dist. find the outer hour-angle, and proceed as in No. 740 (4), to the end.

Ex. 1. March 6th, 1878, at about $5^h\ 55^m$ P.M. M.T.; lat. acc. 40° 15′ S., long. 38° 52′ W., obs. alt. Saturn 11° 50′; also (reduced to the same instant) obs. alt. Aldebaran near meridian 33° 17′; ind. corr. + 1′, height of eye 18 feet: required the Latitude.

The Gr. Date is $6^d\ 8^h\ 30^m$.

Saturn's Red. R.A.	23^h	34^m	24^s
Aldebaran's R.A. + 24^h	28	28	50
Polar angle	4	54	32
The true Alt. of Sat. 11° 41′, lat. 40° 15′, pol. dist. 85° 6′ give Saturn's hour-angle	5	15	19
Aldebaran's hour-angle		20	47
Saturn's Decl 4° 54′ S. pol dist.		85°	6′

Aldebaran's decl. 16° 16′ N.

Aldebaran's obs. alt. 33° 17′, true alt 33° 12

Lat 40°, Decl. 16° (*contrary names*)			0·250
$20^m\ 47^s$		sin. sq.	7·313
	0° 13	sin	7·563
	33 12		
Mer. Alt.	33 25		
Zen. Dist.	56 35 S.		
Decl.	16 16 N		
LAT.	40 19 S.		

Ex. 2. Feb. 2d, 1878, lat. by acc. 54° 53′ N.; obs. alt. Regulus 15° 54′, and the alt of Aldebaran (reduced to the same instant) 51° 17′; ind. corr. − 3′; height of eye 20 feet: required the Latitude.

R.A. Regulus, $10^h\ 1^m\ 55^s$, decl. 12° 34′ N.; R.A. Aldebaran, $4^h\ 28^m\ 57^s$, decl. 16° 16′ N. Regulus' true alt. 15° 43′: Aldebaran's ditto, 51° 19′; hour angle of Regulus, $5^h\ 21^m\ 54^s$, hour-angle of Aldebaran, $11^m\ 4^s$; Red. + 4′. LAT. 55° 3 N.

764. When the change of alt. of one of the bodies is not given by the observation, its altitude cannot be reduced to the same instant as the other by No. 660; to compute it (No. 671), the azimuth is required, which, if not observed with some precision, must be computed. But this reference to the altitude may be avoided, thus:—

Add the interval of time, increased by 1^s for every 6^m, to the R.A. of the body first observed, and subtract the R.A. of the body last observed; the rem. is the polar angle.

If the sum exceed 24^h, reject 24^h.

Ex. 1st. June 24th, 1878, lat. by acc. 40° N., long. 149° 52 W.; time by chron. $24^d\ 0^h\ 1^m$, obs. alt. of α Andromedæ 41° 53′, and $2^m\ 15^s$ afterwards obs. alt. of Jupiter 30° 29′ to the southward; height of eye 16 feet.

Red. R.A. of Jupiter $20^h\ 33^m\ 17^s$, Red. decl. 19° 22 S., *true* alt. 41° 48′.

R A. of α Andromedæ	0^h	2^m	8^s
		2	15
	0	4	23
Jupiter's R.A.	20	33	17
Polar Angle	3	31	6

The hour-angle of α Andromedæ computed from alt. 41° 48′, lat 40, and p l. dist. 61° 35′, is $3^h\ 50^m\ 33^s$.

The difference between the polar angle and the hour-angle of α Andromedæ leaves Jupiter's hour-angle $19^m\ 27^s$, which gives Red. + 10′, mer. alt. 30° 33′, and LAT. 40° 5′ N.

Ex. 2. Jan. 3d, 1878, lat. by acc. 54° 50′ N, obs. alt. Regulus 17° 21, and $3^m\ 40^s$ afterwards obs. alt. Rigel 26° 46′ S; ind. corr. − 5′, height of eye 16 feet: required the Latitude.

R.A. Regulus, $10^h\ 1^m\ 54^s$, decl. 12° 34′ N., R A. Rigel $5^h\ 8^m\ 42^s$, decl. 8° 21′ S; polar angle $4^h\ 56^m\ 52^s$; true alt. Regulus, 17° 9′, hour-angle Regulus $5^h\ 11^m\ 57^s$; hour-angle Rigel $15^m\ 5^s$; Red. to this + 5′. Lat. 54° 59 N.

765. When the body nearest the meridian is observed below the pole, *add* the hour-angle of the other to the polar angle: the suppl. to 12^h of this sum is the inner hour-angle, to which compute the Reduction.

Ex. March 21st, 1831, off Cape Horn, lat. by acc. 56° 50′ S., long. 65° W., at night, obs true alt. α Pavonis 24° 38′, not long past the mer. below the pole; and after $3^m\ 15^s$ obs. alt. γ Crucis 64° 47′; both stars rising, and both to the S. of E.

α Pavo R.A.	$20^h\ 12^m\ 17^s$
Irt.	+ 3 23
	20 15 40
γ Crux R.A.	− 12 21 50
Polar Angle	7 53 50

The hour-angle of γ Crux, computed from alt. 64° 47′, lat. 56° 50′, and pol. dist. 33° 50′, is $3^h\ 6^m\ 18^s$.

This hour-angle, added to the polar angle, gives hour-angle of α Pavo $11^h\ 0^m\ 8^s$, or $59^m\ 52^s$ below the pole. The Red. to this is 38′, and the mer. alt. 24° 0′ gives Lat. 56° 44′ S. (Decl. of α Pavo, 57° 16′ S.)

2. *Neither of the Altitudes (of Two Bodies) being near the Meridian.*

766. *Limits.* These are the same as for No. 749.

767. *The Observation.* Take an alt. of the outer body, then of the inner one, and, lastly, of the outer one, noting the times. At each observation note whether the body is to the northward or southward of E. or W. (true).

768. *The Computation.* The approximate method.

(1.) Take out the right ascens. of the bodies from the Nautical Almanac, reducing them, if necessary, to the Green. Date. Take the diff. of R.A., or its suppl. to 12^h, for the polar angle.

If the 2d alt. of the first body be lost, proceed by No. 763. The result is the polar angle.

(2.) Correct the altitudes.

(3.) Compute the hour-angle of each body.

When the bodies are on the *same* side of the meridian, take the *diff.* of the hour-angles; when on *opposite* sides, their *sum*, for the computed polar angle.

If this sum, or diff., agree tolerably well with the polar angle, the lat. by acc. is near enough; if not, proceed as in No. 752 (5) to find the corr. of lat.

Ex. I. Feb. 25th, 1830. H.M.S. Eden, lat. by acc. 11° 45′ S., long. 19° W., took alts. of Canopus and Sirius as following, both stars to the E. of the mer., and both to the southward of the E. point.

	Canopus.		Sirius.		Canopus.	
	$5^h\ 43^m\ 11^s$	46° 58′·4	$5^h\ 48^m\ 0^s$	71° 47′·4	$5^h\ 51^m\ 4^s$	47° 27′·4
	5 45 25	47 7·2	5 50 0	72 14·6	5 54 0	47 33·4
Means	5 44 18	47 2·8	5 49 0	72 1·0	5 52 32	47 30·4

Sirius R.A.	$6^h\ 37^m\ 40^s$	Decl. 16° 29′·7 S.	Pol. Dist. 73° 30′·3
Canopus	6 20 11	52 36·5 S.	37 23·5
Polar Angle	17 29		

Reducing the alt. of Canopus to the time $5^h\ 49^m$ gives alt. required, 47° 18′·4. The true alt. of Canopus, 47° 13′·6, and of Sirius, 71° 56′·7.

Hour-angle of Canopus	$1^h\ 2^m\ 57^s$	
Hour-angle	$1^h\ 2^m\ 57^s$	sin. 9·433
Pol. Dist.	37° 23′	sin. 9·783
Alt.	47 14	sec. 0·168
Azim.	14°	sin. 9·384

Hour-angle of Sirius	$1^h\ 11^m\ 52^s$
Ditto Canopus	1 2 57
Diff. or comput. Pol. Angle	8 55
Pol. Angle	17 29
Error	8 34

Hour-angle	$1^h\ 11^m\ 52^s$	sin. 9·489
Pol. Dist.	73° 30′	sin. 9·982
Alt.	71 57	sec. 0·509
Azim.	73°	sin. 9·980

Table 71, Part I., 14° and 73°		9·392
	Lat. sec.	0·009
$8^m\ 34^s$	pr. log.	1·322
Corr. of lat. 34′	pr. log.	0·723

The obs. are on the *same* side of the merid. and of the pr. vert.; both hour-angles are to be marked V; the comput. int. the *lesser*; the greater hour-angle is with the greater azimuth; 34′ is to be *subtracted* from 11° 45′, which gives the Lat. 11° 11′ S.

Ex. 2. (The Ex. No. 765.) The computed hour-angle of α Pavo is $11^h\ 5^m\ 0^s$; the diff of which, and $3^h\ 6^m\ 18^s$, is $7^h\ 58^m\ 42^s$, the computed polar angle, which is *greater* than $7^h\ 53^m\ 50^s$. The error is $4^m\ 52^s$.

The azim. of α Pavo is 8°, that of γ Crux 71½°; the corr. of lat. by Table 71, Part I., is 6′, which, since in this case the *greater* hour-angle $11^h\ 5^m\ 0^s$ is with the *lesser* azimuth, is to be *subtracted* from 56° 50′, and gives Lat. 56° 44′ S., as by the other solution.

Ex. 3. Dec. 1st, 1878, lat. by acc. 41° 28′ N.; obs. alt. of Markab, 59° 2′, and that of Altair, reduced to the same instant, 23° 38′; both bodies to the S. and E.; ind. corr. −2′; height of eye 16 feet: required the Latitude.

R.A. Markab, $22^h\ 58^m\ 45^s$, decl. 14° 33′ N.; R.A. Altair, $19^h\ 44^m\ 52^s$, decl. 8° 33′ N.; true alt. of Markab, 58° 55′; that of Altair, 23° 30′; polar angle, $3^h\ 13^m\ 52^s$; Markab's hour-angle, $1^h\ 11^m\ 44^s$; Altair's hour-angle, $4^h\ 24^m\ 26^s$. Then $4^h\ 24^m\ 26^s - 1^h\ 11^m\ 44^s = 3^h\ 12^m\ 42^s$. Azimuth of Markab, 35°; azimuth of Altair, 80°. Corr. of lat. 11′ to be added to 41° 28′. Latitude, 41° 39′ N.

Ex. 4. May 1st, 1878, lat. by acc. 29° 48′ S; obs. alt. of Altair, 26° 24′, and the obs. alt. of Arcturus, reduced to the same instant, 32° 23′; the bodies on different sides of the meridian, and to the north; ind. corr. +2′; height of eye 14 feet: required the Latitude.

R.A. of Altair, $19^h\ 44^m\ 52^s$, decl. 8° 33′ N.; R.A. of Arcturus, $14^h\ 10^m\ 9^s$; decl. 19° 49′ N.; polar angle, $5^h\ 34^m\ 42^s$; true alt. of Altair, 26° 20′; do. of Arcturus, 32° 20′; hour angle of Altair, $3^h\ 31^m\ 43^s$; Arcturus' hour-angle, $2^h\ 2^m\ 3^s$; error, $0^m\ 56^s$; azimuths, 62° and 34°; corr. of lat. 6′ to *sub.* from 29° 48′. Latitude, 29° 42′ S.

769. The error of the correction of lat. is directly proportional to the error of the interval: hence, when the moon is employed, her R.A. should be computed for the actual time at Greenwich, as given by the chronometer, or found from observation of a lunar distance rather than by means of the erroneous long. by account.

Ex. April 7th, 1831, lat. by acc. 34° 40′ S., long. 42° W.; true alt. ☽ 38° 27′ to the N.W. At the same time, true alt. ☉ 47° 44′ to the NE-d; Gr. M.T. by lunar observation, $2^h\ 14^m\ 13^s$: required the Latitude.

☉ R.A. $1^h\ 2^m\ 41^s$, pol. dist. 96° 42′; ☽ R.A. $20^h\ 52^m\ 28^s$, pol. dist. 74° 10′; ☉'s hour-angle $0^h\ 36^m\ 45^s$ E.; ☽ ditto, $3^h\ 35^m\ 27^s$ W.; ☉'s az. 14°; ☽ ditto, 81°; suppl. of diff. of R.A. $4^h\ 10^m\ 13^s$. The error of the computed polar angle is $1^m\ 59^s$, corr. of lat. +6′, and Lat. 34° 46′ S.

This Ex. may be worked by No. 763 (3), thus: the ☽'s hour-angle, $3^h\ 35^m\ 27^s$, subtracted from $4^h\ 10^m\ 13^s$, gives the ☉'s hour-angle $34^m\ 46^s$. The Reduction to this is 49′, and Lat. 34° 45′ S.

3. *The General Solution, for the same, or different Bodies* *

770. (1.) Find the polar angle. This, for the sun, is properly an interval of A.T; but mean time is near enough. For a star, see No. 753. For the moon or a planet, see Nos. 754, 755.

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* Though this method is general, yet it is not well adapted to cases of short intervals (No. 727); because, in such cases, a small arithmetical inaccuracy in the process may produce a considerable error in the resulting latitude, as the reader may easily convince himself by working examples. This is the chief ground on which an approximate and indirect method is often superior, in practice, to the rigorous method.

In the figure in the note, p. 268, omitting the lines P D, Z D, and Z F, are A is A B, A and B are the places of the same body at different times, or of different bodies; angle B

For different bodies, it is the diff. of their R.A.

Find the polar distances at each observation; in assigning these, one pole must necessarily be assumed as the elevated pole, whether the lat. be approximately known or not. Correct the altitudes, and reduce them to the second place of observation, and find the zenith distances.

(2.) For the Arc A. Take the suppl. of the polar angle; and add the pol. dists. together. Add together the log. sine square of the suppl. and the log. sines of the pol. dists.; the sum (rejecting tens) is the log. sine square of an arc x.

Put x under the sum of the pol. dists.; take the sum and diff. and half the sum and half the diff. Add together the log. sines of the last two terms: the sum (rejecting tens) is the log. sine square of an arc A.

(3.) For the angle B. Add together the arc A and the two polar dists.; take half the sum, and from it subtract the arc A and the outer pol. dist., noting the two remainders. If the half sum is the lesser, subtract it from the other quantity.

Add together the log. cosec. of A, the log. cosec. of the outer pol. dist., and the log. sines of the remainders: the sum (rejecting tens) is the log. sine square of the angle B.

(4.) For the angle C. Add together the arc A and the two zenith dists., and from half the sum subtract A and the outer zen. dist.; note the two remainders. If the half sum is the lesser, subtract it from the other quantity.

Add together the log. cosec. of A, the log cosec. of the outer zen. dist., and the log. sines of the two remainders: the sum (rejecting tens) is the log. sine square of the angle C.

(5.) For the angle D. This is the sum, or diff., of B and C, according to the following directions:—

In the case of the same body.

Observations on the *same* side of the Meridian			Observations on *different* sides of the Meridian		
Pol. Dist. *greater* than Colat.	Pol. Dist. *less* than Colat.		Pol. Dist. *greater* than Colat.	Pol. Dist. *less* than Colat.	
	greater Alt. with *lesser* Azim.	*greater* Alt. with *greater* Azim.		Interval *less* than 12^h	Interval *greater* than 12^h
diff.	*sum*	*diff.*	*diff.*	*sum*	*diff.*

Note.—The difference of bearing in the interval must be *less* than 180°.

is P B A; angle C is Z B A; angle D is P B Z, which is P B A − Z B A. When P Z is larger and P A smaller, P B Z may be P B A + Z B A. Then the two sides P B, B Z, with the included angle P B Z, give P Z.

In the case of two stars, A and B are very nearly constant, and have accordingly been computed for certain pairs of stars, and inserted in tables, by which the computation is materially shortened.—*Tables for facilitating the Computation of Double Altitudes*, by Lieut. Shadwell, R.N. 1836.

(6.) For the Latitude. Take the supplement of D to 180°. Take the sum of the outer polar and zenith distances.

Add together the log. sine square of the suppl. of D and the log. sines of the outer pol. and zen. dists.: the sum (rejecting tens) is the log. sine square of an auxiliary arc *y*.

Put this arc under the sum of the zen. and pol. dists.; take the sum and diff., and half sum and half diff.

Add together the log. sines of the last two terms: the sum (rejecting tens) is the log. sine square of the colatitude, reckoned from the same pole as the pol. dists.

Ex. 1. Interval, 32ᵐ 54ˢ; the 1st and *outer* alt., corrected and reduced to the 2d place, is 58° 39′ 42″; the 2d alt. 62° 59′ 36″; outer pol. dist. 104° 24′ 30″; the other, 104° 24′ 12″.

For the Arc A.

Interval	0ʰ 32ᵐ 54ˢ		
Suppl.	11 27 6	sin. sq.	9·997761
Pol. Dist.	104° 24′ 30″	sin.	9·986121
Pol. Dist.	104 24 12	sin.	9·986130
Sum	208 48 42		
Auxly. arc *x*	150 3 42	sin. sq.	9·970012
Sum	358 52 24		
Diff.	58 45 0		
Half Sum	179 26 12	sin.	7·992640
Half Diff.	29 22 30	sin.	9·690660
Arc A	7° 57′ 52″	sin. sq.	7·683300

For the Angle B.

Arc A	7° 57′ 52″	cosec.	0·858367
Outer p. d.	104 24 30	cosec.	0·013879
Inner p. d.	104 24 12		
	216 46 34		
	108 23 17		
	100 25 25	sin.	9·992773
	3 58 47	sin.	8·841384
Angle B	90° 59′ 20″	sin. sq.	9·706403

For the Angle C.

Arc A	7° 57′ 52″	cosec.	0·858367
Outer z. d.	31 20 18	cosec.	0·283921
Inner z. d.	27 0 24		
	66 18 34		
	33 9 17		
	25 11 25	sin.	9·629028
	1 48 59	sin.	8·501014
Angle C	51° 16′ 31″	sin. sq.	9·272330

The observations are on the *same* side of the meridian, and the pol. dist. *greater* than the colat.: hence D is the *diff.* of B and C, and is therefore 39° 42′ 49″.*

For the Latitude.

Arc D	39° 42′ 49″		
Suppl.	140 17 11	sin. sq.	9·946759
Outer Pol. Dist.	104 24 30	sin.	9·986121
Outer Zen. Dist.	31 20 18	sin.	9·716079
	135 44 48		
Auxly. Arc *y*	83 45 20	sin. sq.	9·648950
	219 30 8		
	51 59 28		
	109 45 4	sin.	9·973668
	25 59 44	sin.	9·641773
	79° 55′ 24″	sin. sq.	9·615441
LATITUDE	10 4 36 S.		

* A general rule for assigning the sum or the diff. of B and C, in the case of diff'. alts

This process is less troublesome than it appears. The 1st and 4th steps are of the same form. as are, also, the 2d and 3d.*

Ex. 2. Lat. by acc. 12° S.; true alt. of Sirius, 71° 56′ 42′, pol. dist. 73° 30′ 18″; true alt. of Canopus, 47° 13′ 36″, pol. dist. 37° 23′ 30″; diff. of R.A. 17ᵐ 29ˢ. Both stars to the eastward, and Sirius the *outer* one or easternmost.

The arc *x* is 99° 22′ 15″; A is 36° 16′ 45″; angle B, 4° 30′ 10″; angle C, 100° 10′ 33″; the angle D, the *sum* of B and C, is 104° 40′ 43′. The arc *y* is 38° 54′ 38″, and the LAT. 11° 13′ 27″ S.

771. *Degree of Dependance.* The lat. by double altitude is affected by the errors of altitudes, pol. dists., and interval, or polar angle. The effect is the same, whether by the approximate or rigorous process.

(1.) To find the error of lat. caused by 1′ error in one of the alts. To the log. 3·431 add the log. sine of the azimuth at that alt. and the log. from Table 71: the sum (rejecting tens) is the prop. log. of the error required, nearly.

Ex. Suppose in Ex. 1, No. 768, the alt. of Canopus is 3′ in error.

		3·43	The ERROR OF LAT. is therefore about 3′ 24″.
Canopus az. 14°	sin.	9·38	
14 and 72°, Tab. 71		9·39	
1′ 8″		2·20	

(2.) The error of pol. dist. will be worth notice only in the case of the moon, in consequence of her rapid change of declination, and the uncertainty of the Green. Date.

Find the error of each hour-angle in which the moon's pol. dist. is involved by No. 615 (3). This gives the error of the computed interval; and the error of the correction of lat. is the same part of the corr. itself, that the error of the computed interval is of that interval.

(3.) The error of the rate of the watch will rarely be sensible.

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bodies, would require the hour-angies to be known; but the observer who is well acquainted with the positions of the circles, as shewn in the figures, p. 162, will perceive at the time of observation how the angle D is composed.

* When the lat. is found, the hour-angle and azimuth may be computed thus:—

For the hour-angle. To the log. sine of D add the log. sine of the outer zen. dist. (already taken out) and the log. sec. of the lat.: the sum is the log. sine of the hour-angle corresponding, or of its suppl. Circumstances will usually decide; but, in a doubtful case, take the sum of the log. sines of the decl. and lat.: if this is less than the log. cos. of the zen. dist., the hour-angle is found; if greater, take the supplement.

For the azimuth. To the log. sine of D add the log. sine of the outer pol. dist. (already taken out) and the log. sec. of the lat.: the sum is the log. sine of the azim. or its suppl. If this is doubtful, when the sum of the log. sine of the lat. and cos. of the zen. dist. is less than the log. sine of the decl., the azim. is found; if greater, take the suppl. Reckon the azimuth from the N. in N. lat., and S. in S lat.

V. By the Altitude of the Pole Star.

772. *The Observation.* Observe the alt. of the pole star, noting the time. On shore, note also the thermometer and barometer.

773. *The Computation. At Sea.* (1.) The error of the Watch on A.T. being known, take the R.A. of the sun from the Nautical Almanac, or Table 61, and add the A.T. of observation to it: the result is the R.A. of the meridian.

(2.) Correct the alt. for index-error, dip, and refraction.

(3.) Enter Table 51 with the R.A. of the mer. and the alt.; take out the correction, and apply it as there directed: the result is the latitude, north.

Ex. 1. July 5th, 1890, at $11^h\ 2^m$ P.M. app. time, obs. alt. of the pole star, 51° 20′; ind. corr. + 2′; height of eye 16 feet: required the Latitude.

App. Time		$11^h\ 2^m$
R.A. ⊙		6 58
R.A. Mer.		18 0
✱ Obs. Alt.		51° 20′
Ind. Corr.	+ 2′	
Table 38	− 5	− 3
		51 17
$18^h\ 0^m$, Alt. 50°		+ 27
Lat.		51 44 N.

Ex. 2. March 11th, 1890, at $3^h\ 30^m$ A.M. app. time, obs. alt. of the pole star, 53° 51′; ind. corr. − 3′; height of eye 12 feet: required the Latitude.

App. Time		$15^h\ 30^m$
R.A. ⊙		23 26
		38 56
		− 24
R.A. Mer.		14 56
✱ Obs. Alt.		53° 51′
Ind. Corr.	− 3′	
Table 38	− 4	− 7
		53 44
$15^h\ 0^m$, alt. 50°		+ 1 9
Lat.		54 53 N.

774. *Accurately.* (1.) Find the Greenwich Date; reduce to it the Sid. T. at mean noon; take out the star's R.A. and decl. from the Nautical Almanac, and find the pol. dist.

Find the star's hour-angle.

(2.) Correct the altitude, accurately.

(3.) For the 1st Correction. To the log. sec. of the hour-angle add the prop. log. of the pol. dist.: the sum (rejecting tens) is the prop. log. of the 1st Correction.

For the 2d Correction. To the log. cosec. of the hour-angle add the prop. log. of the pol. dist; double the sum; add to this the const. 1·5821 and the log. cot. of the altitude: the sum (rejecting tens) is the prop. log. of the 2d Correction.

(4.) When the hour-angle is *greater* than 6^h and *less* than 18^h, *add* the 1st Corr. to the altitude; when the hour-angle is *less* than 6^h or *greater* than 18^h, *subtract* it.

Add the 2d Correction in all cases

Ex. July 24th, 1890, long. 0h 6m W.; at 10h 24m 12s·8 obs. alt. of Polaris in the quicksilver, 109° 36′ 40″; ind. corr. −1′ 30″, therm. 62°, bar. 30·0 inches: required the Latitude.

Gr. Date, 24th, 10h 30m 13s		
Sid. T. mean noon, 24th		8h 8m 18s·2
10h	1m 38s·6	
30m	4·9	+1 43·5
13s	0	
Red. Sid. Time		8 10 1·7
M.T.		10 24 12·8
R.A. Mer.		18 34 14·5
✶ R.A.		−1 14 2·1
Hour-angle		17 20 12·4
Or		5 20 12·4

1st Corr.		2d Corr.	
5h 20m 12s Sec.	0·7625	cosec.	0·0066
P.D. 1° 16′ 56″ P.L.	0·3692	P.L.	0·3692
1st Corr. 13′ 17″ P.L.	1·1317		0·3758
			2
			0·7516
		Const.	1·5821
		54° 47′ cot.	9·8487
		2d Corr. 1′ 11″ P.L.	2·1824

✶ R.A.	1h 14m 2s·1	
Decl.	88° 39′ 31″	
Alt.		109° 36′ 40
Ind. Corr.		− 1 30
		2)109 35 10
		54 47 35
Ref. 41″, Ther. 1		−40
True Alt.		54 46 55
1st Corr.		13 17
2d Corr.		1 11
LAT.		55 1 23 N.

775. *Degree of Dependance.* The error is very nearly the same as that of the alt., as a small error of time produces but little effect.

N.B.—The Nautical Almanac method for obtaining Latitude from Pole Star is strongly recommended. Every year tables are calculated expressly for this purpose. Where accuracy is required, as in observations for latitude made on shore, these yearly tables should always be used.

CHAPTER VI.

FINDING THE TIME.

I. BY A SINGLE ALTITUDE. II. BY DIFFERENCE OF ALTITUDE NEAR THE MERIDIAN. III. BY EQUAL ALTITUDES. IV. RATING THE CHRONOMETER.

776. In consequence of the perpetual revolution of the celestial bodies, the hour-angle of any one of them affords the measure of time, No. 471, &c. By whatever method, therefore, the hour-angle may be determined, the time may be deduced. At sea, where the only fixed object to which the ever-changing positions of the celestial bodies can be referred is the horizon, altitude is the only means of determining the time.

I. BY A SINGLE ALTITUDE.

777. The sun's hour-angle being apparent time, when his alt. is observed, the time is at once determined. In the case of any other

celestial body which does not pass the meridian with the sun, it is necessary to allow for the difference of their hour-angles, or of their right ascensions (No. 471), at the instant of observation, by referring both bodies to the first point of Aries (from which R.A. is reckoned), as will be described.

1. *Altitude above the Horizon.*

778. *Limits.* The body should be nearly E. or W., because, when on the prime vertical, errors, both of the latitude of the observer, and of the altitude observed, produce the least effect on the hour-angle.

In general, however, the body may be observed at any time, while moving at the rate of not less than 6′ of alt. in 1^m of time; because in this case an error of 1′ in the alt. will cause not more than 10^s error of time, and the same error of lat. will in the same case cause a still smaller error of time. The *smallest* azimuth, reckoned either from N. or S., which the body can have under this last condition, is seen in Table 46, in the column of 6′.

On the other hand, the alt. should not be observed when small, as, for ex., under 10° or 15°, on account of the uncertainty of refraction, especially in very hot or very cold weather.

779. In lat. 60° 24′ and upwards, 1′ error of alt. must always cause more than 10^s error of time; the body should therefore be observed as nearly E. and W. as possible.

In the tropics, on the other hand, the time may often be more correctly determined, when the body is less than an hour from the meridian, than at several hours from it in high latitudes.

At sea, the uncertainty of the sea-horizon may sometimes be removed by observing to opposite points. Errors of alt. proper to the instrument, or to the eye, are obviated by observing the alt., of the same measure, on opposite sides of the meridian.

[1.] *To find Apparent Time, and thence Mean Time, by the Altitude of the Sun.*

780. *The Observation.* Observe a set of altitudes, (Number 557) at the proper limits, noting the times. See also No. 535.

For accuracy, note the thermometer and barometer.

781. *The Computation.* (1.) Having found the time corresponding to the altitude, find the Green. Date by the chronometer No 575, which will be mean time; or by the time roughly estimated and the long. by acc., No. 576, which will generally be App. Time Reduce to this the sun's declination, No 580, or, for common purposes at sea, this may be done by No. 579. Find the sun's polar distance, No. 443.

When mean time is required, reduce the Equation of Time No. 583 or 584.

(2.) Correct the alt. at sea by No. 617, or, if greater accuracy is required, by No. 649.

(3.) Compute the sun's hour-angle, No 614.

(4.) When the sun is to the W. (or P.M.), this hour-angle is

Apparent Time; when he is to the E. (or A.M.), subtract the hour-angle from 24^h: the remainder is A T. reckoned on the *day before*.

(5) For Mean Time. Apply the reduced equation of time as directed in p. I. of the Nautical Almanac, or in Table 62, to the App. Time: the result is Mean Time.

The difference between the time of observation, as shewn by the watch, and either of these times, is the error of the watch on that time.

Ex. 1.* Jan. 12th, 1902, at sea, at about $9^h\ 30^m$ A.M. app. time; lat. 35° 35′ N.; long. 14° W.; height of eye, 30 feet; ind corr. + 4′ 30″; obs. alt. of sun as below; required app and mean time, and the error of the watch on each time, at the instant of observation.

Note.—The differences of the alts. and the times are taken to test their accuracy by means of their agreement with each other, No. 556.

		Diff.			Diff.
Times by W.	$9^h\ 30^m\ 28^s$	$0^m\ 35^s$	Alt.	22° 18′ 20″	4′ 40″
	31 3	31		23	3 50
	31 34	33		26 50	3 50
	32 7	27		30 40	3 20
	32 34			34	
	157 46			132 50	
Time	9 31 33		Alt.	22 26 34	

Jan.	$11^d\ 21^h\ 30^m$		
Long. 14° W.	+ 56		
G.A.T. Jan.	11 22 26		
Decl. 11^d	21° 54′ 19″ S.		
Corr.	− 8 52		
Red. Decl.	21 45 27 S.		
	90		
Pol. Dist.	111 45 27		
Eq. Time 11^d	$7^m\ 51^s$		
Corr.	+ 22		
Red. Eq. Time	8 13		
Alt.	22° 39′		
Lat.	35 55	sec.	0·00158
P.D.	111 45	cosec.	0·03207
	170 19		
	85 9	cos.	8·92710
	62 30	sine	9·94793
Hour-angle	$2^h\ 27^m\ 15^s$	sin. sq.	8·99868
A.T.	21 32 45		

Obs. Alt. ☉	22° 26′ 34″
Index error	+ 4 30
Table 38	+ 8 0
True Alt.	22 39 4
A.T. at Ship	$21^h\ 32^m\ 45^s$
Watch	21 31 33
Watch slow for A.T.	1 12
A.T. at Ship	21 32 45
Eq. Time	+ 8 13
M. Time	21 40 58
Watch	21 31 33
Slow for M.T.	9 25
Chronometer Time of Observation	$10^h\ 39^m\ 49^s$
Chr. fast on G M.T.	− 2 31
G.M.T. of Obs.	10 37 18
Ship M.T. of Obs.	9 40 58
	56 20
Long. *See* No. 827	14° 5′ 0″ W.

Ex. 2. March 12th, at about $4^h\ 15^m$ P.M. mean time, lat. 50° 48′ N., long. 65° 58′ E.; obs. alt. ☉ 14° 50′ 10″; corresponding time by W. $4^h\ 13^m\ 54^s$; ind corr. − 2′ 20″; height of eye, 18 feet: required A.T. and M.T. and the error of the watch on each

G M.T. March $11^d\ 23^h\ 51^m$, pol dist. 93° 15′, true alt 14° 55′, Eq. T. + $9^m\ 55^s$; hour-angle P.M. or A.T. $4^h\ 5^m\ 54^s$; watch *fast* on A.T. 8^m; M.T. $4^h\ 15^m\ 49^s$, watch *slow* on M.T. $1^m\ 55^s$.

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* In this example some of the quantities are noted to seconds for the sake of a form; but at sea the nearest minute (to which the hour-angle is here worked) is generally enough, unless the observation itself is remarkably good.

Ex. 3. Oct 20th, 1878, at sea, at $4^h\ 40^m$ P.M. app. time; lat. 41° 18′ S., long. 21° W.; height of eye 16 feet; ind. corr. − 2′; at $4^h\ 28^m\ 56^s$ by watch, obs. alt. ☉ 23° 7′: required A.T. and M.T. and the Error of the Watch on each.

G.A.T. Oct. $20^d\ 6^h\ 4^m$, pol. dist. 79° 31′, true alt. 23° 15′, Eq. T. $-15^m\ 11^s$; A.T. $4^h\ 32^m\ 42^s$; Watch *slow* on A.T. $3^m\ 46^s$; M.T. $4^h\ 17^m\ 31^s$; Watch *fast* on M.T. $11^m\ 25^s$.

[2.] *To find Mean Time, and thence Apparent Time, by the Altitude of a Star.*

782. *The Observation* is the same as for the sun, Nos. 541, 542.

783. *The Computation.* (1) Having found the means of the times and the altitudes, take from the Nautical Almanac, or Table 63, the star's R.A. and declin., and also from the Nautical Almanac, or Table 61, the sidereal time at mean noon for the given day.

(2) Correct the altitude, No. 652 or 653.

(3) Compute the star's hour-angle, No. 614.

(4) When the star is to the W. of the meridian, *add* the hour-angle to the star's R.A.; when to the E., *subtract* the star's hour-angle from its R.A. (increased if necessary by 24^h); the result is the R.A. of the meridian.

From the latter (increased if necessary by 24^h) subtract the sidereal time at mean noon; the rem. is the approximate M.T.

From this last subtract the Retardation upon it, Table 24.

Take out the Acceleration for the long.; in W. long *subtract* the Accel. from the result, in E. long. *add* it; the result, if less than 12^h, is Mean Time; if greater than 12^h, reckon the time on the preceding day.

(5.) For App. Time. By the M.T. obtained, and the long. by acc., or by the chronometer, find the Gr. Date; reduce the equation of time and apply it as directed in p. II. of the Nautical Almanac, or the contrary way to that directed in Table 62.

Ex. 1. Jan. 1st, 1902, P.M., lat. 50° 46′ N., long. 61° 37′ W., at $7^h\ 56^m\ 18^s$ by watch, obs. alt of Procyon 15° 40′ to the S. and E., eye 20 feet, ind. err. 0′: required the Mean and App. Times, and the Error of the Watch.

Procyon's R.A. $7^h\ 34^m\ 10^s$; Decl. 5° 28′ N.; Sid. T. mean noon, $18^h\ 40^m\ 48^s$.

Obs. Alt.	15° 40′	Alt.	15° 32′			Hour-angle	$-4^h\ 48^m\ 12^s$
Ind. Corr. 0′ / Table 38 − 8	− 8	Lat.	50 46	sec.	0·19895	★ R.A.	7 34 10
		P.D.	84 32	cosec.	0·00198	R.A. Mer. (+ 24^h)	2 45 58
True Alt.	15 32		150 50			Sid. T. M. Noon −	18 40 48
Chr. at Time of Obs.	h m s 12 11 30		75 25	cos.	9·40103	Approx. M.T.	8 5 10
			59 53	sine	9·93702	Ret.	− 1 19
Chr. fast on Gr.	− 2 15	$4^h\ 48^m\ 12^s$		sin.sq.	9·53898		8 3 51
Gr. M.T.	12 9 15					Accel. 61° 37′ W.	− 40
Ship M.T.	8 3 11					M.T.	8 3 11
Long. in Time	4 6 4					Time by Watch	7 56 18
Long. 61° 31′ 0″ W.						Watch *slow* on M.T.	6 53

The Red. Eq. T. is $3^m\ 34^s$, which *subtracted* from M.T. gives A.T. $7^h\ 59^m\ 37^s$, and the watch *slow* on A.T. $3^m\ 19^s$.

Ex. 2. April 27th, 1902, A.M., lat. 29° 47′ 45″ S., long. 31° 7′ E. at $2^h\ 19^m\ 41^s$ by watch, obtained true alt. of Altair 25° 14′ 20″ to the E. and N.: required the M.T. of observation.

Altair's R.A. $19^h\ 46^m\ 2^s$, Decl. 8° 36′ 35″ N., Sid T. M. Noon $2^h\ 18^m\ 9^s$.

Alt.	25° 14′ 20″		
Lat.	29 47 45	sec.	0·061561
P.D.	98 36 35	cosec.	0·004920
	153 38 40		
	76 49 20	cos.	9·357794
	51 35 0	sin	9·894046
$3^h\ 37^m\ 8^s$		sin sq.	9·318321

Hour-angle	$-3^h\ 37^m\ 8^s$
✱ R.A.	19 46 2
R.A. Mer.	16 8 54
Sid. T. M. Noon	−2 18 9
Approx. M.T.	13 50 45
Ret.	−2 16
	13 48 29
Accel. long. 31° 7′ E.	+0 20
MEAN TIME	13 48 49

[8.] *To find Mean Time, and thence Apparent Time, by the Altitude of the Moon or a Planet.*

784. ***The Observation*** is the same as for the sun. See, also, Nos. 540, 541, 542.

785. *The Computation.* (1.) Having found the means of the times and of the altitudes, find the Gr. Date as nearly as possible by the chron., No. 575, or by the estimated M.T. and long. by acc., No. 576. Reduce the moon's R.A., No 591, and decl., No. 589, and thence her pol. dist.; also her horiz. parall., No. 586 or 587, and semid., Table 39.

(2.) Deduce the app. alt., No. 654. Take out the correction of alt., Table 39. Correct the altitude.

(3.) Compute the hour-angle, and proceed as for a star, 783 (4).

Ex. 1. July 21st, 1878, A.M., lat. 39° 57′ N., long. 8° 53 E.; M.T. at Green. by chron. $20^d\ 11^h\ 48^m$, obs. alt ☽ 24° 10′ E. of mer.; eye 16 feet.

☽'s R.A.	$0^h\ 33^m\ 19^s$
Corr.	1 26
Red. R.A.	0 34 45
☽'s Red. H.P.	54′ 13″
☽'s Aug. Semid.	14 53
☽'s Decl.	8° 26′ 35″ N.
	1 2
Red. Decl.	8 27 37 N.
	90
Pol. Dist.	81 32 23

Alt.	25° 8′		
Lat.	39 57	sec.	0·11543
Pol Dist.	81 32	cosec.	0·00476
	146 37		
	73 18½	cos.	9·45822
	48 10½	sin.	9·87226
$4^h\ 16^m\ 45^s$		sin. sq.	9·45067

Obs. Alt.		24° 10
Dip.	−4′	+11
Semid.	+15	
		24 21
Corr. Par.		+47
True Alt.		25 8

☽'s R.A. (+24h)	$0^h\ 34^m\ 45^s$
Hour-angle	−4 16 45
R.A. of mer.	20 18 0
Sid. T.M. Noon	7 52 32
Approx. M.T. at ship	12 25 28
Ret	−2 2
	12 23 26
Accel. for 8° 53′ E.	6
M.T. at Ship	12 23 32

Ex. 2. Feb. 22d, 1878, at about $9^h\ 30^m$ P.M., lat. 42° 40′ N., long. 140° W., obs alt. Mars 23° 43′ W. of mer., time by watch $9^h\ 24^m\ 27^s$ P.M., eye 18 feet: find M.T. and Error of Watch.

G. T. Feb. $22^d\ 18^h\ 50^m$, Mar's Red. R.A. $2^h\ 47^m\ 33^s$, Red. Decl. 1 ° 10 N., True Alt 23′ 37′.

Alt.	23° 37		
Lat.	42 40	sec.	0·13353
P D.	72 50	cosec.	0·01979
	139 7		
	69 33½	cos.	9·54314
	45 56½	sin.	9·85651
$4^h\ 53^m\ 39^s$		sin sq.	9·55297

Hour angle	$4^h\ 53^m\ 39^s$ W.
Mars' R.A.	2 47 33
R. A. of Mer.	7 41 12
Sid. T. M. Noon	22 9 2
Approx. M.T.	9 32 10
Ret.	− 1 34
	9 30 36
Accel. 140° W.	− 1 32
M.T.	9 29 4

Whence the watch is $4^m\ 37^s$ *slow* on M.T.

786. When the true G.M.T. is given by a chronometer, the moon's R.A. and declination may be correctly found. When the moon is at her greatest declination, N. or S., a small error in the Gr. Date will but slightly affect her pol. dist. An error of 1^m in the Gr. Date causes about 2^s error in the moon's reduced R.A.

787. If the errors of the watch, as found by observation of two bodies on different sides of the meridian, but on the same side of the prime vertical, by the same observer with the same instrument, be not identical, that error is nearest to the true error of the watch which accompanies the greater or outer azimuth. If the azimuths are equal, the mean of the errors is the true error.

788. *Degree of Dependance.* The alt. and the lat. being in general, at sea, more or less uncertain, and the pol. dist. of the sun and moon being reducible with precision in certain cases only, the time is in general liable to three causes of error. See No. 615.

When it is proposed to test the observation, the parts to 30″ for the sec., &c., will be taken out with those quantities.

2. *By the Altitude 0, or the Body on the Horizon.*

789. In low latitudes the entire orb of the sun is, during certain seasons, frequently seen at rising and setting; and in the variable climates of high latitudes it is occasionally visible, though more usually clouded at those times. When the instant at which either limb touches the horizon can be distinctly noted, the time may be determined approximately; and though the degree of approximation be rude as compared with some other methods, yet the result may often be valuable, especially after one or more days without observation. It is also a recommendation to this method, as a resource when others fail, that it is independent of every instrument except a watch or other means of measuring time.*

(1.) Find the time of sunrise or sunset in Table 26. Apply to this the long. in time, as directed, No. 576: the result is the Green. Date. Reduce the declination, and find the pol. dist.

(2.) To the horizontal refraction, 33′, add the depression, Table 8, and from the sum *subtract* the semid. when the *lower* limb is ob-

* Mr. Fisher acquaints me that he has employed this observation on a few occasions, but circumstances were not convenient for comparing the results with those of other observations.

served, or *add* it when the *upper* limb is observed: the result is the angular depression of the sun's centre below the horizon at the instant of observation.

(3.) Compute the hour-angle of the sun below the horizon by No. 642, using, instead of 18°, the sun's depression.*

(4.) At sunset this hour-angle is app. time; at sunrise take the suppl. to 12 hours.

Ex. 1. May 12th, 1878, lat. 51° 20′ N., long. 26° W., observed the sun's lower limb at setting touch the horizon at $7^h\ 40^m\ 56^s$ by watch; eye 16 feet: required App. Time.

☉ Decl 18°, Table 26 gives		Hor. Refr.	33′	Depr.	0° 21′		
App. Time Sunset	$7^h\ 35^m$	Depr.	4	Lat.	51 20	sec.	0·20427
Long. 26° W.	1 44		37	P.D.	71 44	cosec.	0·02246
G.A.T. 12th	9 19	Semid.	−16		123 25		
Decl. 12th	18° 10′ N	Depr. Centre	21		61 42	sin.	9·04472
Corr.	+ 6				61 21	cos.	9·68075
Red. Decl.	18 16 N.			A.T.	$7^h\ 40^m\ 7^s$	sin. sq.	9·85220
				Watch	7 40 56		
					0 49 Watch *fast.*		

Ex. 2. Oct. 14th, 1878, lat. 18° 39′ N., long. 62° 30′ E., the sun's upper limb at rising appeared on the horizon at $5^h\ 46^m\ 11^s$ by watch; eye 20 feet: required App. Time.

Gr. Date, Oct. $13^d\ 14^h\ 0^m$, red. decl. 8° 3′ S.; depr. of sun's centre 54′; Hour-angle $5^h\ 52^m\ 54^s$; App. Time $6^h\ 7^m\ 6^s$ A.M.; watch $20^m\ 55^s$ *slow* on A.T.

790. *Degree of Dependance.* This we have at present no certain *data* for determining, more especially when the observation is taken from a considerable elevation, as from a hill.

The terrestrial refraction does not, it should seem, affect the instant of the apparent passage of a celestial body over the visible horizon, since the rays of light from the horizon and those from the body are similarly affected; and hence the uncertainty of the result is probably due entirely to that of the astronomical refraction at the time and place. It may be proper, accordingly, to admit an error of 2′, at least, in the refraction; and the effect on the result is then found by merely adding together the parts for 30″ of the cosine and sine, dividing the sum by the parts for 1^s of the sine square, and doubling the result.

Ex. In Ex. 1, above, the parts are 34 and 116; the sum, divided by 20, gives $7\frac{1}{2}^s$, which, doubled, is 15^s, the effect due to 2′ error in the refr. In Ex. 2 this is 8^s.

* In the tropics the method No. 638 may be substituted, using log. sine depr. ☉ cent.

As an aid to the working of a sun chronometer, Davis's "Chronometer" Tables will be found very useful: they contain hour angles calculated exactly for degrees of Latitude, Altitude, and Declination, with means of making allowance for the minutes which must be taken into account. J. D. Potter, 145 Minories, London, E., price 10*s.* 6*d.*

II. By Difference of Altitude near the Meridian.

791. When the sun is too near the meridian for a satisfactory observation of a single altitude, the time may be determined approximately, and sometimes nearly, by means of the observed difference of alt. in a measured interval.

The method has been already introduced in the Short Double Altitude, p. 256, and it was on the ground that the same observation might be usefully employed for Time also, that the small corrections from p. 223, which are scarcely appreciable in the resulting latitude, were applied. It is also worth while, in finding the time by this method, to correct for change of declination.

The method (as already shewn in Case II., p. 259) is available with alts. taken on both sides of the meridian; but, as this case would be comparatively rare, the rules have been arranged for observations on the *same* side of the meridian only.*

792. *Limits.* The observations should both be within an hour from noon. The interval should constitute a large portion of the mid. time from noon; but it should not, generally, amount to the whole time from noon.

The Observation is that in No. 726.

793. *The Computation.* (1.) Reduce the declin., by the long., to noon at the place, which will be near enough.

(2.) Find the interval, and correct the second of the times by watch for the rate in the interval, when considerable. Correct the alts., and reduce the 1st to the place of the 2d; find their mean and their difference. Correct the diff. of alts., and also the interval by the quantity in the Table, p. 223.†

(3.) Compute the hour-angle at the middle of the interval, No. 729 (2), and add half the interval. When the observation is P.M. this is App. T., and being compared with the second time by watch, shews the error of the watch. When the observation is A.M., take the suppl. of this time to 12^h.

Note. If the rising or falling of the sun has not been distinctly noticed, or it is uncertain whether the alts. are on the same or different sides of the meridian, ascertain the fact by the precept, No. 728.

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* For the like reason, namely, not to increase unnecessarily the number of precepts, the observation below the pole is not treated; this presents no difficulty.

† This is the quantity which, added to the sine, makes it equal to the arc, and by means of it we employ the table of sines equally well for arcs.

Ex. 1. May 14th, 1878, about 11^h A.M., lat. 48° 4′ N., long. 21° 11′ W., at $11^h\ 28^m\ 20^s$ by watch, obs. alt. ⊙ 58° 9′; at $11^h\ 52^m\ 50^s$ by watch, obs. alt. ⊙ 59° 39′; ind. corr. −1′ 20″; height of eye, 16 feet; rate, $5\frac{1}{2}$ knots, ⊙ a-head at 1st obs.: required the Error of the Watch.

Times by Watch	$11^h\ 28^m\ 20^s$	Alt. ⊙	58° 9′ 0″	Alt. ⊙	59° 39′ 0″	Alts.	58° 21′ 11
	11 52 50	Ind. Corr.	−1 20		−1 20		59 49 1
Interv.	24 30	Dip	−4 0		−4 0		118 10 12
Corr.	+3		58 3 40		59 33 40	Mean	59 5 6
	24 33	Corr. Alt.	−32		−30	Diff.	1 27 50
⊙ Decl. 14th	18° 40′ N.		58 3 8		59 33 10	Corr.	+1
21° W.	+1	Semid.	+15 51		+15 51		1 27 51
Red. Decl.	18 41 N.		58 18 59	2d Alt.	59 49 1		
		Run	+2 12				
		1st Alt.	58 21 11				

Diff. Alts.	1° 27′ 51″	sine	8·4074	Hour-angle	$0^h\ 44^m\ 44^s$
Interv.	$24^m\ 33^s$	cosec.	0·9710	Comp. Mid. T.	11 15 16
Lat.	48° 4′	sec.	0·1750	Half Int.	+12 15
Decl.	18 41	sec.	0·0235	T. of 2d Obs. computed	11 27 31
Mean Alt.	59 5	cos.	9·7108	Do. by Watch	11 52 50
Hour-angle	$0^h\ 44^m\ 44^s$	sine	9·2877	Watch *fast*	25 19

Ex. 2. Lat. 10° 41′ S., red. decl. 20° 56′ N., alts. ⊙ 58° 2′ and 57° 17′, interval $12^m\ 14^s$ Computed App. Time of 2d Observation, $0^h\ 39^m\ 0^s$.

794. *Correction for Change of Declination.* When the sun is on the meridian, his motion in declination (which then takes place on the meridian) is perp. to the horizon, and consequently affects the alt. by exactly the same quantity. When, on the other hand, that part of the sun's celestial meridian or declin. circle, on which he is, is parallel to the horizon, his change of declin. does not affect the alt. at all. Hence the corresponding change of alt. is always between 0 and the whole amount of change of declination.

The 2d alt. differs therefore by the whole, or a part, of the change of declin. in the interval, from what it would have been had the decl. remained constant. When the motion in declin. tends to increase the alt. the 2d alt. is too great; otherwise too small. There is, however, no necessity, in this method, for a very nice process of correction, for when the mer. alt. is small, and the sun not far from the meridian, the motion. in declin. corresponds very nearly to that of alt., and the entire change may be applied; and when, on the other hand, the mer. alt. is great, the motion in alt. is so rapid, that a few seconds, in the estimation, are of no consequence in practice, or the whole quantity may even be neglected.

Ex. 1. May 3rd, 1878, lat. 26° 14′ N., long. 161° W., at $10^h\ 31^m\ 18^s$ by watch, obtained true alt. ⊙ 71° 49′, and at $11^h\ 7^m\ 21^s$ true alt. 77° 46′: find the Error of the Watch.

The Hour-angle is $46^m\ 18^s$, Mid. T. $11^h\ 13^m\ 42^s$, and Watch *slow* $24^m\ 22^s$.

Ex. 2. Nov. 4th, 1878, P.M., lat. 63° 46′ N., long. 54° W., at $2^h\ 14^m\ 56^s$ by watch, obs. alt ⊙ 10° 18′ 1′, and at $2^h\ 36^m\ 27^s$ obs. alt. ⊙ 10° 2′ 29″. Ind. corr. +2′, height of eye 10 feet, the ship having no way.

The diff. alts. 15′ 40″, and Int. $21^m\ 32^s$ (corr. by 1^s), give Mid. T. $25^m\ 46^s$. The change of decl. 17″, added to 2d alt. gives diff. alts. 15′ 23″, and corrected Mid. T. $25^m\ 18^s$.

795. *Degree of Dependance.* As the interval may be measured

with precision, and as the lat., declin., and alt., are required approximately only, the value of the result depends almost entirely on the diff. alts.

(1.) The error of the mid. time due to a given error in the diff. alt. is found by taking away the sine employed, and adding that of the diff. alts. vitiated by a proposed error. The result is more trustworthy as the diff. alts. is greater.

In Ex. 1, No. 793, lat. 48° 4′ N., an error of 30″ in the diff. of alts. causes 15ˢ error of time; the obs. alts. would be better nearer noon.

In Ex. 1, No. 791, 30″ error of diff. alts. causes 4ˢ error of time.

In Ex. 2, No. 793, 30″ error of diff. alts. causes 22ˢ error of time.

In Ex. 2, No. 794, lat. 63° 46′, 30″ error of diff. alts. causes 48ˢ. The case is unfavourable from the smallness of the motion in alt.

(2.) The chief merit of the method is its insensibility to an error in the latitude, which, under the same circumstances, renders the observation of a Single Alt. useless. The effect of a proposed error is found by changing the sec. lat. before employed for the sec. of the lat. proposed.

In the following examples the effect of an error of lat. in the result by Single Alt. also is noted for comparison of the two methods.

In Ex. 1, No. 794, lat. 26° 14′, 10′ error of lat. (that is, using 26° 24′) causes only 4ˢ error of time. The effect of this error on the time by the single alt. 71° 49′ would be 28ˢ.

In Ex. 2, No. 793, 10′ error of lat. causes 1ˢ error of time. The error of time by the single alt. 57° 17′ would be 2ᵐ 9ˢ.

Since a single alt. very near the meridian cannot be employed for finding the time, and since the latitude at sea is usually uncertain some miles, unless it has been determined very recently, the above method is adapted to finding the time at ship during that portion of the day when the single altitude is not practicable.

III. By Equal Altitudes.

796. Since the altitude of a body which does not change its declination varies exactly at the same rate while rising on the E. side of the meridian as while falling on the W. side, the same altitude occurs at the same hour-angle on each side of the meridian, and the middle point of time between the instants of two equal altitudes is the instant at which the body passes the meridian. Hence the time and, consequently, the error of the watch, may be found by observation of equal altitudes.

In the case of the sun, the middle point of time, or the mean of the observed times of equal altitudes A.M. and P.M., is apparent noon. In the case of a star, or other celestial body, the mean of the observed times corresponds to the R.A. of the star when on the meridian, that is, to the sidereal time, which may be converted into A.T. or M.T.

797. Since the sun changes his declination sensibly in large intervals of time, two equal alts. A.M. and P.M. do not in general correspond to equal hour-angles, and it becomes necessary to apply to the mean of the observed times a correction, which is called the *Equation of Equal Altitudes.*

The object of the computation is to find what time the watch shewed when the body was on the meridian; the rate, therefore, does not affect the result, unless it is irregular, in which case the mean of the A.M. and P.M. times is not the time shewn by the watch when the interval is half expired.

In like manner, the variation of the sun's motion in R.A. (which is the variation of the equation of time) produces no effect, provided it be uniform. The irregularity of this variation is inconsiderable

1. *Equal Altitudes at Sea.*

798. When the course made good during the interval of the observation of two equal altitudes is true E. or W., the ship changes her longitude only by the portion of time which she gains or loses on the sun in the interval; this change introduces no correction, and the only question is the time by watch when the interval is half expired. But when the ship changes her latitude, the same altitude no longer corresponds to the same time from noon, and a correction becomes necessary.*

799. This method, though but approximate, has some advantages: it is independent of the terrestrial refraction, provided this remains unchanged in the interval employed; and the correction for change of lat., when necessary, requires the lat. and alt. to be but roughly known. In the tropics the interval may in general be very small, on account of the rapid change of altitude, and the correction for change of latitude in such cases may sometimes be omitted. In high latitudes, on the contrary, the ship's change of latitude considerably alters the time from noon at which the 2d alt. (which should be equal to the 1st) is taken: hence, in such cases, the method is less useful.

Note.—As the equation of equal alts. is generally a small quantity as compared with the correction due to change of place, we shall not here consider it. If, however, it is required to introduce it, proceed afterwards to No. 806.

800. *The Observation.* Observe the sun's alt. before noon, noting the time. Note the instant of the same alt. of the same limb P.M. For greater accuracy, several equal alts. should be obtained.

When the motion in alt. is quick, both limbs may be observed.

801. *The Computation.* (1.) Take the mean of the A.M. and P.M. times by watch; this, when the ship does not change her lat., is the mean time by watch of apparent noon. Then the Equation of Time *applied as to Mean Time*, will give the time of mean noon at ship as shown by the watch. Applying to this the error of the watch on Greenwich will give Greenwich time at the mean noon of the ship, which is the longitude in time.

* N.B.—The altitude should not be less than 70°, or the time from noon more than 10^m.

(2) Correction for change of latitude. With half the interval as an hour-angle compute the azimuth, No. 676.

To the log. sine of half the D. Lat. made good, add the log. sec. of the lat., and the log. cotan. of the azim.: the sum, rejecting tens, is the log. sine of the correction, *in time*.

When the ship has *approached* the sun in the interval, *subtract* this time from the above mean; when she has *receded* from the sun *add* it: the result is the time by watch at apparent noon.

Ex. 1. June 8th, 1826, lat. by acc. 6° N., at $2^h 43^m 1^s$ by watch (A.M.) and at $3^h 0^m 3^s$ (P.M.) obs. alt. ☉ 84° 30′ to the northward; course, N.N.W. true, rate, $3\frac{1}{2}$ knots.

The interval, 17^m, gives Dist. run 1·1 mile and D. Lat. 1.

Alt. (true)	84° 46′	sec.	1·040	D. Lat.	30″	sin.	6·163
Decl.	22 50	cos.	9·965	Lat.	6°	sec.	0·002
Half-Int.	$8^m 31^s$	sin.	8·570	Az.	22°	cot.	0·394
Azim.	22°	sin.	9·575	Corr.	$-0^h\ 0^m\ 5^s$	sin.	6·559
					2 51 32		
				T. by Watch of App. Noon	2 51 27		or Watch *fast*.

Here the sun is to the northward, and the course is to the northward, or the ship has *approached* the sun.

Ex. 2. June 22d, 1828, at sea, lat. 4° S., course S.W. true, rate $7\frac{1}{2}$ knots, obs. alts of the sun to the northward; ship receding from the sun.

Alt. ☉ 59° 44	Times	$12^h\ 29^m\ 57^s$ A.M.	$2^h\ 8^m\ 39^s$ P.M.
50		30 53	7 37
55		31 45	6 45
	Means	12 30 52	2 7 40 int. $1^h\ 37^m$
			0 30 52
	Approx. T. by Watch of noon		1 19 16 or Watch fast.

The Dist. run in $1^h\ 37^m$ is 12m.; D. Lat. made good, 8′·5.

Alt.	60°	sec.	0·301	D. Lat.	4′ 15″	sin.	7·092
Decl.	$23\frac{1}{2}$	cos.	9·962	Lat.	4°	sec.	0·001
Half Int.	$48^m\ 30^s$	sin.	9·322	Azim.	$22\frac{1}{2}$°	cot.	0·383
Azim.	$22\frac{1}{2}$°	sin.	9·585	Corr.	$+0^h\ 0^m\ 41^s$	sin.	7·476
					1 19 16		
				T. by Watch of App. Noon	1 19 57		

or *error* of the watch, *fast*.

802. *Degree of Dependance.* (1.) The error of time due to an error of 1′ in one of the alts. is half that due to 1′ change of alt., No. 788 (1.)

(2.) To find the error due to an error of 1′ in the D. Lat. made good, divide the correction obtained by the D. Lat. For ex., 1′ error in Ex. 2 causes 5^s error in the correction.

2. *Equal Altitudes on Shore.*

803. The method of equal altitudes is susceptible of considerable accuracy, but it can be completely put in practice on shore only, as the sea-horizon is always subject to uncertainty.

[1.] *The Sun, Morning and Evening.*

805. *The Observation.* In the A.M., when the sun is within the limits (No. 778), set the index of the sextant at the altitude, nearly; clamp the index, and observe the instant of the alts. of both limbs, noting the times. Do the same in the afternoon, when the limbs will follow in reverse order.

The value of the method consists in the same altitude being repeated, without regard to the precise measure of it. But as the second or corresponding altitude is often lost by a cloud hiding the object, the usual practice is to set the index to certain whole divisions, as 10′, 20′, &c., and to observe the altitudes. The moving of the index destroys, indeed, the integrity of the method, since the second altitude is no longer identical with the first, but is merely inferred to be equal to it from the reading. The errors, however are greatly diminished by taking numerous altitudes: or a number of instruments may be employed, set to different altitudes.

806. *The Computation.* (1.) Reckon the time P.M. as 12^h, 13^h, &c., instead of 0^h, 1^h, &c. Add together the A.M. and P.M. times of observation; take the mean of these sums, and divide it by 2. Take the difference between the 1st and 3d times (as set down in the example below) to the nearest minute, and call it the interval.

(2.) Find the Greenwich Date for apparent noon at the place; reduce the sun's decl. (p. I. of the Naut. Alm.) to the nearest minute only, marking it as of the *same* or *contrary* name to the latitude, and as *increasing* or *decreasing*. Reduce the equation of time, p. I. Naut. Alm.

(3.) Take the sum of the changes of the sun's declination for the 24^h before and the 24^h after the Gr. Date; call this the double change.*

(4.) Compute the equation of equal altitudes thus:—

Part I. From Table 72 take out the logarithms A and B. To log. A add the log. cot. of the latitude and the prop. log. of the double change: the sum, rejecting tens, is the prop. log. of Part I.

Part II. To log. B add the log. cot. of the decl. and the prop. log. of the double change: the sum, rejecting tens, is the prop. log. of Part II.

(5.) Apply these parts, which form the equation, to the approximate noon by watch, by the following directions.

	Part I.		Part II.	
	Lat. and Declin.		Interval	
	of the *same* name.	of *contrary* names.	*less* than 12 hours.	*greater* than 12 hours.
Declination increasing	*sub.*	*add*	*add*	*sub.*
Declination decreasing	*add*	*sub.*	*sub.*	*add*

The result is the time shewn by the watch at the instant the sun was on the meridian, or apparent noon by the watch, and therefore shews the error of the watch on A.T.

To obtain the error on M.T. To apparent noon, $0^h\ 0^m\ 0^s$, or

* As the decl. in Table 60 is given only to the nearest minute, the daily change, as taken from this table, may be a minute in error. This will not cause an error of 1^s in the equation of equal alts.; but, for precision, the Nautical Almanac is necessary.

12h 0m 0s, apply the reduced Equation of T. as directed p. I. of the Naut. Alm., or Table 62: the result is the *mean time* of the sun's meridian passage (as in No. 624). By comparing with this the time of apparent noon by the watch, its error on mean time is found.

Three places in the logarithms give the equation to 0s·1.*

Ex. 1. Feb. 15th, 1830, at Ascension, lat. 7° 57′ S., long. 14½° W., the following observations of the sun's limbs were taken in the quicksilver, the sextant being clamped at 81°.

A.M.	P.M.	Sums, deducting 24.	
10h 45m 40s	17h 29m 19s	4h 14m 59s	Red. Decl. 12° 44′ S.
10 47 54	17 27 8·5	4 15 2·5	Eq. of T. 13m 50s·5 *additive.*
	Sum	8 30 1·5	
		4 15 0·7	Two-daily change, 39′ 18″,
	Approx. Noon by Watch	2 7 30·3	*decreasing.*

From 10h 46m
to 17 27
Int. 6 41 — log. A 2·218; Lat. cot. 0·855; 39′ 18″ p. l. 0·661

Part I. 2s·0 — pr. log. 3·734

Lat. and decl. *same* name; decl. *decreasing*, add.

Log. B 2·412
Decl. cot. 0·646
0·661

Part II. 2s·1 — 3·719

Int. less than 12h; decl. *decreasing*, subtract.

Approx. Noon		2h 7m 30s·3
−2·1 / +2·0	Eq. of Eq. Alts.	−0·1
App. Noon by Watch		2 7 30·2
Eq. of T. *additive*, or Mean Noon, No 624		13 50·5
Watch fast on M.T.		1 53 39·7

Ex. 2. July 24th, 1878, lat. 55° 1′ N., long. 0h 6m W., obtained following observations of sun's limbs in the quicksilver, the sextant being clamped at 49°.

A.M.	P.M.	Sums deducting 24h.
7h 6m 51s	17h 12m 39s·5 ...	0h 19m 30s·5
7 10 27·5	17 8 57 ...	0 19 24·5
	Sum	55·0
		0 19 27·5
		0 9 43·7

☉'s Red. Decl. 19° 52′ N. *decr.*
Two daily change 25′ 1″
Eq. of T. 6m 14s·1 *addit.*

Int. 10h 2m; Part I., 15s·6, lat. and decl. *same* name; decl. *decreasing*, add. Part II., 1s·0 int. less than 12h; decl. *decreasing*, subtract; app. noon by watch, 0h 9m 58s·3; Eq of T. additive, or M.T. of Mer. Pass. 0h 6m 14s·1. Watch fast on M.T. 0h 3m 44s·2.

[2.] *The Sun, Evening and Morning.*

807. Instead of observing A.M. and P.M. on the same day, it is often convenient to observe on the afternoon of one day and the morning of the next.

The Computation. (1.) Take the mean of the times as directed; No. 806; this is the approximate time by watch of apparent midnight. Find the interval as in No. 806.

(3.) Find the Green. Date in app. time for midnight at the place

* It is often convenient, when all possible accuracy is required, to employ the logarithms of numbers. In this case, take the arith. complements of the logs. A and B, employ the tangents of the lat. and decl., and the log. of the two daily change in seconds.

Ex. (the above.)

Log. A 2·2183	ar. co.	7·7817
Lat.	tan.	9·1450
39′ 18″ = 2358″	log.	3·3725
Part I. 1s·99	log.	0·2992

Log. B 2·4121	ar. co.	7·5879
Decl.	tan.	9·3541
...		3·3725
Part II. 2s·06	log.	0·3145

Reduce the sun's decl. and the Eq. of Time.

(3.) Find the double change, as before directed.

(4.) Compute the equation of equal altitudes, apply the 1st part the contrary way to (5): the result is the time by watch of apparent midnight.

Ex. Feb. 22d, 1830, P.M., and Feb. 23d, A.M., lat. 7° 57′ S., long. 14½° W., obtained observations of equal altitudes.

P.M.	A.M.	Sums (—12h).	
$5^h\ 18^m 32^s$	$10^h\ 59^m 47^s$	$4^h\ 18^m 19^s$	Decl. 12° 44′ S., *decreasing.*
5 19 36	10 58 41	4 18 17	Eq. of T. $13^m 46^s{\cdot}4$, *additive.*
5 20 40·5	10 57 36	4 18 16·5	
		52·5	Double change, 43′ 8″
		4 18 17·5	
	Approx. Midnight by Watch	2 9 8·7	

Part I.

	$5^h\ 19^m$		
	10 58		
Int.	5 39	log. A	2·235
		Lat. cot.	0·855
		43′ 8″	0·614
	$-2^s{\cdot}2$		3·704

Part II.

Log B	2·307
Decl. cot.	0·646
	0·614
$2^s{\cdot}5$	3·627

The int. is greater than 12^h, that used for log. A being its suppl. The Eq. of eq. alts. is $+0^s{\cdot}3$; the watch fast on M.T. $1^h\ 55^m\ 22^s{\cdot}6$.

[3.] *Equal Altitudes of a Star.*

808. This observation determines the absolute time with much precision and convenience, as there is no equation of equal altitudes.

809. *The Computation.* (1.) The mean of the times shewn by the watch is the time by watch corresponding to the sidereal time, or R.A. of the merid., which, in this case, is the same as the R.A. of the star.

(2.) Find M.T. by No. 607, and thence the error of the watch.

810. *Correction for Change of Refraction.* As the method of equal altitudes is capable of much precision, and as the rate deduced may be much affected by small errors in the absolute time, it is worth while to make the proper correction for every cause of inaccuracy. A shift of wind or a fall of rain, in the interval, may be accompanied by a change of refraction, which, especially when the altitude is low, may produce a sensible effect. To allow for this,

(1.) Find the correction of the refraction at both observations for the barom. and therm., Tables 32, 33; then, when the corrections differ,

(2.) To the prop. log. of their diff. add the prop. log. of the time the sun takes to move through his diameter (which, if not shewn by the observation, may be found by note *, p. 221), and the ar. comp. of the prop. log. of the semi-diameter; the sum is the prop. log. of a portion of time, *half* of which is to be applied to the time of noon, or midnight, thus:—

1st obs. A.M., or to the eastward, when the east. refr. is the *greater, add;* when the *lesser, subtract.*

1st obs. P.M., or to the westward, when the east. refr. is the *greater, subtract;* when the *lesser, add.*

Ex. May 21st, 1830, Fort Villagagnon, Rio de Janeiro, lat. 22° 55′ S., long. 43° W. obtained equal alts. 57° in the quicksilver, A.M. and P.M.; the refr. at the eastern observation 12″ *less* than at the west.

Reduced decl. 20° 50′ N. (of *contrary* name to lat. and *increasing*), double change 24′ 36″ Eq. of T. $3^m 44^s·7$, *subtr.* from A. T.

A.M.	P.M.	Sums	
$7^h 21^m 54^s$	$13^h 25^m 6^s$	$20^h 47^m 0^s$	The int. 6^h from
7 23 23	13 23 36	20 46 59	$7^h 22^m$ to $13^h 22^m$
7 24 56	13 22 4	20 47 0	gives the two parts
3 2		140 59	$+ 3^s·7$ and $+ 2^s·2$, or
		20 46 59·7	the equation of eq.
		10 23 29·8	alts. $+ 5^s·9$.

Correction for unequal refraction.

12″	prop. log.	2·95
$3^m 2^s$	do.	1·77
15′ 49″	Ar. co. do.	8·94
$2^s·3$	prop. log.	3·66
Corr. $- 1^s·1$		

Approx. Noon by Watch	$10^h 23^m 29^s·6$
Eq. Equal Alts.	$+ 5·9$
	10 23 35·7
Corr. for Refract.	− 1·1
App. Noon by Watch	10 23 34·6
Eq. of T. $+ 12^h$	12 3 44·7
Watch slow on A. T.	1 39 25·4
Watch *slow* on M.T.	1 32 40·7

811. *Degree of Dependance.* The error of the equation of equal altitudes caused by an error in the double change of decl. is a matter of simple proportion. The effects of small errors in the lat. and decl. are insensible, therefore neither the lat. of the place nor the declin. is required to great precision. But variations in the refraction, not to be removed by corrections, will always leave the result in some degree doubtful. On this account, the method, even under the most favourable circumstances, can rarely be considered as affording extreme precision.

IV. Rating the Chronometer.

812. The Rate of a chronometer is the difference of its error from day to day. It is called *gaining* when the watch goes too *fast*, and *losing* when it goes too *slow*.

813. When the chronometer is *fast*, either on G. M. T. or on the time at place, if the error is *increasing*, the rate is *gaining*; if *decreasing*, the rate is *losing*. When the chron. is *slow*, if the error is *increasing*, it is *losing*; if *decreasing*, it is *gaining*.

The amount of the daily rate (supposed uniform) is found by dividing the change of the error by the number of days in the interval between the observations.

Ex. May 27th, at 9^h A.M. chron. slow		$2^h 7^m 18^s$
June 3d, at 5^h P.M.	slow	2 6 51
	Diff. of Error in $7^d 8^h$	0 0 27

Then 27^s, divided by 7·33 days, gives $3^s·7$ DAILY RATE, *gaining*.

814. When the error is found to have changed from fast to slow, or from slow to fast, the rate is the sum of the errors divided by the number of days elapsed.

Ex. 1. June 28th, at 3 P.M., the chron. was $0^m 7^s·0$ fast; on July 5th it was $0^m 16^s·1$ slow: required the Daily Rate. The sum $23^s·1$, divided by 7 (days), gives $3^s·3$, *losing*.

Ex. 2. On the 14th, the chron. was $0^m\ 17^s$ slow; on the 31st, it was $0^m\ 12^s$ fast: required the Rate. The sum $0^m\ 29^s$, divided by 17, gives $1^s{\cdot}7$, *gaining*.

815. As the chronometer rarely goes for any length of time without some irregularity, the rate should be deduced afresh at every opportunity. This is done, 1st, by finding the *absolute error on the time* at place, by observation, after intervals of a few days; 2dly, by direct comparison of the *interval of time* shewn by the chronometer with that measured by a clock of known rate, or with the motion of a star. Also, as longitude is measured by time, No. 479, the absolute longitudes of places, when correctly laid down, and their differences of long. may be employed in a corresponding manner.

All observations for the purpose of rating a chronometer should be made, if possible, on shore, on account of the uncertainty of the sea-horizon, because a small error in the absolute time may produce a great error in the daily rate deduced. Also, the observations should be made by the same person with the same instrument, and under the same circumstances, as nearly as possible.

1. *By Comparison with the Absolute Time, or Longitude*

[1.] *By the Time.*

816. The best observation (out of the observatory) for the purpose, is equal altitudes carried on for several days. The next in value is the same alt. repeated several days successively, in the same part of the day; for the times determined by A.M. and P.M. sights on the same day do not, it appears, agree exactly either at sea or on shore.*

As the rate cannot be depended upon for a considerable length of time, it is necessary to take frequent opportunities of obtaining alts. on shore by the artificial horizon. It is proper, therefore, to remark, that by a little care, and by not mixing A.M. and P.M. sights, the rate may be determined nearly as well as by equal altitudes.

817. At sea, the lunar observation, No. 836, or, under very favourable circumstances, the moon's altitude, No. 864, affords the absolute error of the chronometer on G. M. T., and may discover, accordingly, if any considerable change in the rate has taken place; but it would be highly injudicious to attempt to establish a rate from observations so discordant as these usually are.

818. An excellent method has been afforded of late years, of determining the error and rate of the chronometer by the establishment of time-balls at some observatories. These, with the G. M. T. at the instant the ball is dropped, are given in Table 13. The time-ball obviates the necessity of observations for rate.

819. When the ship leaves any place, and after an interval not much exceeding a fortnight returns to it again, the error of the

* The late Captain Hewett informed me, that being obliged to keep account of the daily rates of his chronometers, by means of altitudes observed from the sea-horizon, while surveying the North Sea, in H.M.S. Fairy, the constant discrepancies between the A.M. and P.M. sights rendered it necessary to employ the A.M. sights alone.

chronometer accumulated in her absence is found directly by comparing the time shewn by the chronometer with the times obtained by observation both at her departure and at her return. The error thus found affords the actual *sea-rate*, and the method, when it can be practised, is far more efficient than that of deducing harbour rates.

Ex. By an observation taken immediately before the ship's departure from a port the chron. was found slow $3^h\ 27^m\ 14^s$. By an observation taken at her return, or 11·3 days afterwards, the error was $3^h\ 27^m\ 44^s{\cdot}5$, or $30^s{\cdot}5$ more. Hence the RATE during her absence has been, on the average, $2^s{\cdot}7$ *losing*.

[2.] *By the Longitude.*

820. When, on making a well-determined point of land, the long. by chron. does not agree with the actual position of the ship, and when, accordingly, the chronometer must have been going at a different rate from what was supposed, it will be convenient to refer to the following Table.

	Sailing E.	Sailing W.
	The Chronometer has	
The land not made so soon as expected.	gained less, or lost more,	gained more, or lost less,
The land made unexpectedly.	gained more, or lost less,	gained less, or lost more,
	than allowed for.	

Ex. A ship from India to the Cape of Good Hope makes the land unexpectedly.
The ship is sailing W., the land made too soon; the chron. has therefore gained less or lost more than allowed for.

But it must be borne in mind that chronometers do not preserve the same rates, generally speaking, for a long time together; and, therefore, after a considerable interval, as upwards of a fortnight, this method shews only the gain or loss *on the whole*, not whether the chronometers are gaining or losing now.

2. *By Comparison of Intervals, of Time, or Longitude.*

[1.] *By a Clock.*

821. The chronometer being compared at different times with a clock of which the rate is known (as in No. 564), the difference of the errors for the intervals is obtained, and thence the rate is deduced. The mode of comparison is already described, p. 203.

[2.] *By a Star.*

822. Since every star returns to the same point of the heavens $3^m\ 55^s{\cdot}91$ of mean time earlier every mean solar day, the return of the same star to the same altitude, or to the wire of a fixed telescope, day after day, determines the rate very correctly. The alt. should

be considerable, in order to avoid errors of refraction, and the telescope, for the same reason, should be nearly in the meridian.

To find the rate, multiply $3^m\ 55^s{\cdot}91$ by the number of days elapsed, and subtract the product from the first time noted; the remainder is the time the chronometer would shew if it went uniformly, and the difference between this and the time it shews is the difference of the error for the interval, which gives the daily rate.

Ex. At an observation of a star on May 1st, the chron. shewed $7^h\ 51^m\ 11^s$; after four days it shewed $7^h\ 35^m\ 44^s{\cdot}6$: required the Daily Rate.

First time noted	$7^h\ 51^m\ 11^s$
$3^m\ 55^s{\cdot}91 \times 4$	− 15 43·6
	7 35 27·4
	7 35 44·6
Gaining in four days	17·2

hence the DAILY RATE is $4^s{\cdot}3$, *gaining*.

The disappearance of a star behind any elevated object answers the same purpose.

[3.] *By Difference of Longitude.*

823. When the error of the chronometer upon the time at any known place A is compared with the error on the time at another known place B, the difference between these two errors is the diff. long., in time, between the places. Hence if the difference of the errors does not agree with the Diff. Long. found from Table 10, or in Table of Secondary Meridians, p. 392, the discrepancy arises from a wrong rate having been employed in the interval between the observations for time, and the true rate may be found by trial, as in the following example:—

Ex. At Falmouth, Feb. 3d, at $3^h\ 20^m\ 18^s$ M.T. by observation, the chron. shewed $4^h\ 31^m\ 47^s$, or was $1^h\ 11^m\ 29^s$ fast. At Funchal, on the 12th, at $5^h\ 30^m\ 27^s$ M.T., or 9·1 days afterwards, the chron. shewed $7^h\ 29^m\ 34^s$. The supposed rate, $2^s{\cdot}3$ *gaining*. The D. Long. in Table 10 A is $47^m\ 28^s$. Required the true rate.

Obs. at Falm., T. by chron.	$4^h\ 31^m\ 47^s$
M.T. by obs.	3 20 18
1st error, fast	1 11 29

Obs. at Funchal, T. by chron.	$7^h\ 29^m\ 34^s$
$2^s\ 3 \times 9{\cdot}1$ d. *gain*	− 21
	7 29 13
M.T. by obs.	5 30 27
2d error, fast	1 58 46
1st error, ditto	1 11 29
Difference, or *chron. D. Long.*	47 17

This diff. should be $47^m\ 28^s$, or is too small by 11^s. By inspecting the process, it is evident that the quantity 21^s (which, from the nature of the case, is supposed to be in error) is too large by 11^s. The RATE, therefore, is 10^s divided by 9·1, or $1^s{\cdot}1$ *gaining*.

When one error is fast and the other slow, make them both fast or both slow, by adding or subtracting any number of hours.

3. *Keeping Account of the Chronometer.*

824. In keeping account of the chronometer, the error on G.M.T. is entered in a book as fast or slow, with the date, and the rate is applied to this according as it is gaining or losing, day by day.

If, after a time, the long. or G.M.T. be obtained independently, the error on G.M.T. is found; if this does not agree with the rate allowed, a new rate must be assigned from consideration of the circumstances.

825. As it is impossible, without an independent reference, to determine whether a chronometer, A, is gaining upon another, B, or B is losing while A goes as before, no direct rules of certain application can be given for reducing the rates of chronometers by mere comparison. Since, however, it may be presumed, in general, that in a number of watches the true time will be that shewn by the majority, regard being had to the quality of each, it is proper to keep an account, in which an approved watch being taken as the standard, the rest are severally compared with it every day.

It is convenient to distinguish the chronometers by letters, as A, B, C, &c., and to write the difference between A and B thus, A—B; that between A and C thus, A—C, over each column.

Advantage should be taken of favourable opportunities of landing at well-determined places (*see* Table of Longitudes accepted for Secondary Meridians, p. 392) for good observations of time, because the diff. long. between the places will at once discover any considerable change in the rate, afford means of correcting it, and be a means of obtaining the *sea-rates* of the chronometers.

CHAPTER VII.

Finding the Longitude.

I. By the Chronometer. II. By the Lunar Observation. III. By the Altitude of the Moon. IV. By an Occultation. V. By Eclipses of Jupiter's Satellites.

826. The apparent motions of the celestial bodies parallel to the equator, produced by the revolution of the earth round its axis, being perpetual, no fixed point or circle can be obtained from which the longitude of the observer, which is measured, like right ascension, on the equator, may be determined. Longitude, accordingly, can be ascertained only with reference to the meridian of some other place; and, as it is measured by time (No. 193), it is determined by comparison of the time at place with the time at some other place.

I. By the Chronometer.

1. *Determination of the Absolute Longitude.*

827. The most convenient method of finding the longitude is by comparison of the time at place with the time at Greenwich, as shewn by a chronometer.

The mean time at place being found (Chapter VI.), take the difference between this time and the time by chronometer, brought up to the time of observation by applying the error with the rate.

When the time at Greenwich is the *least*, the long. is E.; when the *greatest*, it is W.

Ex. 1. The M.T. at place is $3^h\ 48^m\ 2^s$; the G.M.T. is $4^h\ 15^m\ 11^s$: hence the LONG. of the place is $0^h\ 27^m\ 9^s$, or $6^\circ\ 47'\ 15''$ W.

Ex 2. The M.T. at place is $7^h\ 14^m\ 22^s$; the G.M.T. is $2^h\ 6^m\ 57^s$: hence the LONG. is $5^h\ 7^m\ 25^s$, or $76^\circ\ 51'\ 15''$ E.

828. *Degree of Dependance.* The time at place, as deduced from observation, and the time shewn by chron., being both liable to error, the error of the resulting longitude is made up of the sum or difference of these two errors.

829. When the rate of the chronometer has changed, and the long. is required at a time past, the error of the chronometer at the time proposed must be deduced from the two rates by consideration of the circumstances, as no rule can apply to all cases.

2. *Determination of Difference of Longitude.*

830. The ordinary method is to find the absolute longitudes of both places by comparison of the Greenwich mean time, as above described, and then to take the difference between them.

Ex. M.T., at a place A, is $3^h\ 11^m\ 43^s$, when the G.M.T. is $7^h\ 7^m\ 18^s$: hence the long of A is $3^h\ 55^m\ 35^s$ W. Again, some days afterwards the M.T., at a place B, is $2^h\ 19^m\ 45^s$, when the G.M.T. is $6^h\ 26^m\ 34^s$: hence the long. of B is $4^h\ 6^m\ 49^s$ W.

The DIFF. LONG. between the places is, therefore, $11^m\ 14^s$, and B is west of A.

831. But it is more concise, in a question relating to a *difference* only, to proceed without regard to the absolute longitude of either place, by considering merely the error of the chron. on the time at each of the two places, as in the following example:—

Ex. 1. At $3^h\ 11^m\ 43^s$ M.T., by obs. at a place A, the chronometer shewed $5^h\ 11^m\ 19^s$, or was $1^h\ 59^m\ 36^s$ fast on the time at A. Again, some days afterwards, at $2^h\ 19^m\ 45^s$ M.T., at a place B, the chron. (after applying the rate) shewed $4^h\ 30^m\ 35^s$, or was $2^h\ 10^m\ 50^s$ fast on the time at B.

Now it is evident that if A and B were in the same long., the chron., supposing the rate truly determined, would have the same error at each place; and hence the difference of the errors, $1^h\ 59^m\ 36^s$ and $2^h\ 10^m\ 50^s$, or $11^m\ 14^s$, is the DIFF. LONG.

Since the chron. is *faster* at B than at A, the time at B is *behind* that at A, or B is west of A.

The proceeding, reduced to a rule, is as follows:—

Find, by observation, the error of the chron. on the time at place. Having moved to another place, take an observation for time; correct the time shewn by the chron. by applying the rate for the time elapsed since the former observation, and find the error: the difference of the two errors is the diff. long.

When the chron. is *fast* at both places, the place at which the error is the greatest is *west* of the other.

When the chron. is *slow* at both places, the place at which the error is the greatest is *east* of the other.

When the chron. is fast at one place and slow at the other (as may occur when the error is less than the diff. long.), add 5 or 6 hours to each of the times by chron. in order to render both the errors of the same kind.

Ex. 2. At A, M.T. $5^h\ 36^m\ 10^s$,	chron. $6^h\ 36^m\ 20^s$,	error $1^h\ 0^m\ 10^s$ fast	
At B, M.T. 3 28 30,	chron 4 9 20,	error 0 40 50	
A west of B,		DIFF. LONG. 0 19 20	

832. Since the whole value of a chronometric determination depends upon the rate of the chronometer, and since the rate is liable to change, the result is better as the time occupied in the run is less. This, however, does not, in strictness, apply to intervals less than 24 hours; for the works go through an entire revolution in 24 hours, and the *rate*, which is determined for an entire day, may be unequally distributed over different parts of the 24 hours. For extreme precision, the rate should be known for given intervals on the dial-plate.

833. When the ship returns without loss of time from a place to that from which she set out, the opportunity will in general be very favourable for determining the difference of longitude.

834. While a chronometer continues to gain or to lose, the difference of longitude shewn by it between two places will be differently affected, according as it is measured eastwards or westwards: hence, if the differences do not agree, the true diff. long. will be between them.

When the chron. *gains* on its rate, the computed long. is to the *west* of the true long.; when the chron. *loses* on its rate, the computed long. is to the *east*.

If the rate is steady, the true diff. long. will be correctly found by dividing the error according to the number of the days in the two passages.

3. *Communication of Chronometric Differences.*

835. Individuals possessing one or more good chronometers frequently have opportunities of furnishing, verifying, or correcting meridian distances. It is proper, therefore, here to enumerate the considerations which influence the value of the results, more especially as many such determinations are communicated to authority from time to time, which, however, not being accompanied with the details necessary for an estimation of their value, remain unemployed.

(1.) It is absolutely necessary to specify or to describe the *exact spot of observation* at each place.

(2.) The *number of days* employed in the run, or in the interval between the observations for time, or both, if these differ much, together with the *number of chronometers*, should be expressed; also, the times and manner of rating, and the character of the rate, as steady or unsteady, should be briefly noticed.

(3.) The *maker's name* and the *number* of the chronometer should be specified, because the character of a watch affects the value of a determination in which it is employed.

(4.) When there are several chronometers, the result given by each should be exhibited. The general *arithmetical mean* should be given, and, besides this, an *estimated mean*, obtained by giving more or less weight to the several results, according to the performance of each chronometer, and of which the observer alone can be a judge. The two final results should be expressed in *time*, and also in *arc*, for the more ready comparison of positions on the chart.

(5.) The *extreme difference* of the greatest and least results by the different chronometers employed should be stated, as this shews whether the chronometers went well together or not; for, though their going together does not prove that all or any of them are right, their not going together proves that some of them are wrong.

(6.) All observations for the longitudes of places are supposed to be made by means of the quicksilver, unless the contrary is expressed. When the altitudes are taken from the sea-horizon, the result should, therefore, be distinguished by the word (*sea*).

(7.) It will be useful to state the temperature of the chronometer-room, and to remark whether it has remained constant or been subject to variation. Also, the general direction of the ship's head should be noted.

(8.) Lastly, every result should be given without any regard as to *whether it agrees or not with received determinations.* Many received positions are very erroneous, and the only means by which they can be decisively rectified are the comparisons of independent and impartial evidence.

In the following example, D. L. is the abbreviation of Diff. Long.; ch. is that of chronometers; d. that of days; and the extreme difference is denoted by the number of seconds enclosed in brackets, implying limit or boundary.*

Ex. May, 1838, Capt. A., of H.M.S. ——, sailed from Barbadoes to Port Royal, Jamaica, the points of observation being Engineers' Wharf and Fort Charles. He carried five chronometers, viz., No. 152, Molyneux; No. 192, Breguet; No. 702, Arnold and Dent; No. 650, Parkinson and Frodsham; and No. 490, M'Cabe. The passage occupied seven days. The extreme difference of the results was 7 seconds of time. The arithmetical mean was $1^h\ 8^m\ 49^s$; the estimated mean, $1^h\ 8^m\ 52^s$. The temperature of the chronometer-room ranged from 78° to 80°; the ship's head chiefly west.

These particulars, abbreviated, stand thus:—

Capt. A., May 1838, D. L. *Barbados* (Eng. Wharf) to *Port Royal* (Fort Charles), 5 ch.
7 d. $[7^s]$
Arith. Mean, $1^h\ 8^m\ 49^s = 17°\ 12'\ 15''$
Estim. Mean, $1\ \ 8\ \ 52 = 17\ \ 13\ \ \ 0$

M.	No. 152	$1^h\ 8^m\ 46^s$	
B.	No. 192	1 8 52	
A. and D.	No. 702	1 8 53	Temp. 78° to 80° [2°]
P. and F.	No. 650	1 8 45	Head west.
M'C.	No. 490	1 8 49	

* This plan was proposed in the Naut. Mag., 1839, p. 402, to which the reader is referred for other details of the subject.

II. The Lunar Observation.

Clearing the Distance, Nos. 842, 844, 845—Lunar Obs. by the Sun No. 847—Lunar Obs by a Star or a Planet, No. 849—Special Corrections, No. 851—Degree of Dependance, No. 858—Calculation of Altitudes, No. 863.

836. The angular distance of the moon from any celestial body being in perpetual change, each of the several degrees of magnitude through which it passes corresponds to a certain instant of time. Accordingly, the distance of the moon from the sun and certain other bodies, at the end of every three hours, being given in the Nautical Almanac, the observation of this distance affords the means of determining the time at Greenwich, and thence the longitude of the observer.

This observation, on account of its great importance at sea, has been distinguished by the name of the *Lunar Observation.*

837. If the distance between the moon and the other body were the same to the spectator, whether he were at the surface or the centre of the earth, there would evidently be nothing more to do than to measure the distance by an instrument, to find from the Nautical Almanac the Greenwich time corresponding, and to compare this time with the time at place. But the refraction of the sun, a star, or a planet, being greater than its parallax in altitude, causes one of these bodies to appear *above* its true place; while, on the contrary, the moon's parallax in alt. being greater than her refraction, causes her to appear *below* her true place.

Z is the zenith, S and ☽ the true places of the sun (or star) and moon, S′ and ☽′ their apparent places. Then S ☽ is the true distance, and S′ ☽′ the apparent distance

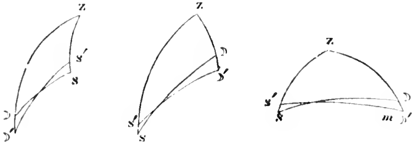

Fig. 1. *Fig.* 2. *Fig.* 3.

SS′ is the sun's corr. of alt., ☽☽′ the moon's corr. of alt. In fig. 1, where the ☽'s alt. is the lesser, the app. dist. exceeds the true, for ☽′ is farther from S than ☽ is, and S′ is also farther from ☽ than S is. In fig. 2, the app. dist. is the lesser. In fig. 3, both angles at S and ☽ are acute, as is the case when the alts. are nearly equal, and always when the distance exceeds 85°.

As ☽☽′ is always less than 56′, the arc ☽ *m*, fig. 3, of a circle, having its centre at S, is nearly a right line, and ☽′*m* (which, from the apparent place of the moon, is here the excess of the app. dist. above the true) is equal to ☽☽′ cos. of the angle at ☽′. The like term (or 1st correction of the app. dist.) for the sun is SS′ cos. S, or SS′ cos. S′ nearly. This is the principle of the approximate methods.*

Hence the *apparent* distance between the moon and the other body differs from the *true* distance, except in the particular case in which the two opposite effects happen exactly to compensate. This last circumstance may sometimes occur during the time that two bodies within distance are above the horizon, but not being discoverable from the observation it is productive of no simplification.

The process of reducing the apparent to the true distance, or removing the effects of parallax and refraction, is called *Clearing the Distance.*

838. It is evident from the above that the difference between the true and apparent distances depends almost entirely on the corrections of altitude (No. 438); and, consequently, is affected by every variation, however minute, of those corrections. Also, since the most rapid change of distance is about 1° 48′ in three hours, the effect of 1′ error of dist. is 25′ of long., or the effect of 15″ error of distance is 6′ of long., in the most favourable case. Hence it may become of great importance to the accuracy of the result, in many cases, that the heights of the barometer and thermometer should be noted at the time of observation.

839. The lunar observation, which is the only independent method of finding the longitude generally available at sea, is also, from not being confined like some others to a particular instant, of service on shore. A single observation, however, is not capable of affording a decisive result; great practice is necessary for measuring the distance successfully; and the application of so many small corrections as are necessary when accuracy is required is, even with extraordinary care and some skill, scarcely compatible with extreme precision.

840. *Limits.* The distance must fall between the greatest and

---

* The approximate process will be easily intelligible by attending to the following considerations.

The moon must always be *raised*, and the sun or star *lowered*, to attain their true places. Now, when the moon is the lower of the two bodies, it is evident that raising her will diminish the apparent distance; that is, her correction of distance must be *subtractive*. Again, when she is the higher body it is generally additive. When the sun or star is the lower body, *lowering* it will increase the app. dist.; its corr. of dist. is therefore *additive*, but subtractive in general when the uppermost body.

The angle at the *lower* body, Z ☽′ S′, or Z S′ ☽′, is *always acute*, the corresponding angle at the other body will generally be obtuse when the altitudes are very unequal, and the dist. not great.

The *correction of dist.* in Method I. is the D. Lat. corresponding to this angle as a course, and the corr. of alt as Dist. The sum or diff. of the Dep. and N is the cosine of the angle in question to the radius 100. When the dist. is less than 90° and the Dep. greater than N, the angle is acute, but obtuse when the Dep. is the lesser. Thus, in Ex. I the angle at the moon is 55 ½; that at the star, 76°.

When the moon's alt. amounts to nearly 80°, or when the distance is so small as 20°, M and N vary irregularly, and Method I. does not serve well.

least distances in the Nautical Almanac. The alts. should not be less than 5° or 6°; and, when the barometer and thermometer are not at hand, not less than 12° or 15°, especially in very hot or very cold weather.

As the chief part of the computation consists of *clearing the distance*, it will be more convenient for reference to consider **this** portion of the work separately.

1. *Clearing the Distance.*

[1.] *Approximate Methods.*

841. In these methods the object is to find the *correction* of the apparent distance due to the corrections of altitude of each body. The first, or that by *inspection*, is performed by means of the Spherical Traverse Table; and the second, by *logarithms*,* is a useful and convenient process, without the embarrassment of various cases, and requiring only four places of figures.

The approximate methods are, in general, not susceptible of much precision when the distance is less than 20°.

842. Method I. *By Inspection.* (1.) For the Moon's Correction of Distance. With the moon's app. alt. and the compl. of the app. dist. to 90°, take out M and N.

With the sun's or star's† alt. as Course, and M as Dist. find the Dep., which place under N.

When the distance is *less* than 90°, take the *difference* of this Dep. and N, marking the Dep. according as it is greater or less than N.

When the distance is *greater* than 90°, take the *sum* of the Dep and N.

With the Dist. 100, and the said *diff.* or *sum* as D. Lat., find the Course.‡ With this course and the moon's corr. of alt. as Dist., find the D. Lat; this is the moon's correction of distance.

For the Moon's 2d Corr. Enter Table 56 with the app. dist. and the moon's corr. of alt., and take out the seconds. Enter again with the corr. of dist. and take out the seconds. The diff. of these two quantities is the 2d corr., which apply as directed in the Table.

(2.) For the Sun's or Star's Correction of Distance. With the sun's or star's app. alt. and the co-dist., take out M and N.

With the moon's alt. as Course and M as Dist. find the Dep., which place under N, marking it as greater or less than N when the dist. is less than 90°.

Take the *diff.* or *sum* as before directed.

With the Dist. 100 and this *diff.* or *sum* as D. Lat. find the Course. With this course and the sun's or star's corr. of alt. as Dist. find the D. Lat.; this is the corr. of distance required.§

* This is a slight variation of the method commonly known among seamen as Norie's 4th method, and attributed to Mendoza Rios.

† In the case of a planet, substitute the word planet for star in the several rules.

‡ If this sum or diff. exceed 100, a mistake has been made.

§ The correction of distance may be found more correctly by multiplying the diff. or sum

Note. In finding the moon's corr. work to the nearest *half degree;* and when the sun's or star's alt. is less than 20°, take out the Dep. to the nearest *third* or *quarter* of a degree. In the sun's or star's corr. work to the nearest *whole degree.*

Apply the corrections to the app. dist. as follows; the result is the true distance.

Distance *less* than 90°				Distance *greater* than 90°	
☽ Corr. of Dist.		⊙ or ✱ Corr. of Dist.		☽ Corr. of Dist.	⊙ or ✱ Corr. of Dist.
When the Dep. is		When the Dep. is			
less than N	*greater* than N	*less* than N	*greater* than N		
add	*sub.*	*sub.*	*add*	*sub.*	*add*
☽ 2d Correct. of Dist. *add*				☽ 2d Correct. of Dist. *sub.*	

Ex. 1. (Dist. *less* than 90°.) App. alt. ⊙ 47° 31′; A. alt. ☽ 36° 52′; app. dist. 48° 20′ 29″. ⊙ corr. of alt. 47″; ☽ corr. of alt. 45′ 35″. (Co-dist. 41½°.)

☽'s Corrections.

☽ 37° and 41½°, M 167,		N	66·6
⊙ 47½° and 167,		Dep.	123·1 (gr.)
		(*diff.*)	56·5

Dist. 100 and D. Lat. 56·5 give the Course 55½; at which,

Dist. 45′ gives D. Lat. 25·5	25′	30″
35″		20
	25	50

(which *sub.*, since 123·1 exceeds 66·6.)

☽ 2d corr. 16″
5 + 11″

⊙'s Correction.

⊙ 47° and 41°, M 194·3,		N	93·2
☽ 37° and 194,		Dep.	116·8 (gr.)
		(*diff.*)	23·6

Dist. 100 and D. Lat. 23·6 give the Course 76°; at which,

Dist. 47″ gives D. Lat. 11″
(which *add*, since 116·8 exceeds 93·2.)

⊙ corr.	+0°	0′	11″
☽ 2 corrs.		−25	39
	−0	25	28
A. dist.	48	20	29
True Dist.	47	55	1

Ex. 2. (Dist. *greater* than 90°.) App. alt. ⊙ 13° 10′; app. alt. ☽ 36° 6′; app. dist. 120° 29′ 53″. Hor. par. 59′ 42″; ☽ corr. of alt. 46′ 58″; ⊙ corr. of alt. 3′ 56″. (Co-dist. 30½°.)

☽'s Corrections.

☽ 36° and 30½°, M 143·4,	N	42·8
⊙ 13¼° and 143·4,	Dep.	32·9
	(*sum*)	75·7

100 and D. Lat. 75·7 give Course 41°.

46′ gives 34′·7	34′	42″
58″		44
	−35	26

☽ 2d corr. 120° and 47′, 11″ }
35, 6 } −5″

⊙'s Correction.

⊙ 13° and 30°, M 118·5	N	13·3
☽ 36° and 118,	Dep.	69·4
	(*sum*)	82·7

100 and D. Lat. 82·7, Course 34°.

3′ gives 2′·5,	0°	2′	30″
56″			46
	+0	3	16
	−0	35	31
	−0	32	15
	120	29	53
True Dist.	119	57	38

(of the Dep. and N) by the correction of alt., pointing off two more decimals than the product contains. The seconds may either be taken separately, or as decimals of a minute.

This process, worked however roughly, affords a check against a mistake in using the Traverse Table.

Ex. 1 of No. 842.

Diff.		56·5
☽ corr. of alt. 45′ 35″		45·6
	Prod.	2576·40
Pointing off two dec.		25·76 or 25′ 46″

Diff.		23·6
⊙ corr. of alt. 47″		47
	Prod.	1109·2
Pointing off two dec.		11·09 or 11″

Ex. 3. App. alt. ☉ 72° 0; app. alt. ☽ 27° 1′; app. dist. 72° 18′ 32″. ☉ corr. of alt. 0 13″; ☽ corr. of alt. 46′ 30″. (Co-dist. 17½°.)

☽ 27° and 17½°, M 117·4 N 15·6	☉ 72° and 17°, M 338·4, N 94·1
☉ 72° and 117, Dep. 111·3	☽ 27° and 338, Dep. 153·0
95·7	58·9
100 and 95·7, Course 17°.	100 and 58·9, Course 54°.
46′ 44 0″	16′, ☉ corr. +0° 0′ 9″
30″ 79	−0 44 28
−44 29	−0 44 19
☽ 2d corr. 72° and 46′, 7″ } +1″	72 18 32
44, 6 }	TRUE DIST. 71 34 13

Ex. 4. (Correcting for the barom. and therm.) Suppose, in Ex. 2 above, the barom. is 30·7 in. and the therm. 38°; the ☽ corr. of alt. will be 46′ 54″, by No. 655, and the ☉'s corr. of alt. 4′ 9″, No. 651.

46′ 34′ 42″	4′ 3′ 18″
54″ 41	9″ 7
−35 23	+3 25
	TRUE DIST. 119° 57′ 50″

843. The following examples exhibit those steps only which, in proceeding by No. 842, a practised computer will find it necessary to write down. The errors are marked against each result as given in Dr. Inman's "Navigation."

Ex. 1. ☉ A. alt. 25° 20′; ☽ A. alt. 25° 35′. ☉ corr. of alt. 1′ 52″; ☽ corr. of alt. 48′ 21″; app. dist. 104° 37′ 49″. (Co-dist. 14½°.)

114·4 12·1	113·7 11·6
49	50·0
(52°) 29′ 36″ 61·1	61·6
13	(52°) +0° 1′ 9″
−29 49 4″, +4″	−0 29 45
0	−0 28 36
	104 37 49
	TRUE DIST. 104 9 13 (3′ too small).

Ex. 2. A. alt. Spic. Virg. 48° 0′; A. alt. ☽ 69° 48′. ✱ corr. alt. 51″; ☽ ditto, 18′ 39″. Hor. par. 55′; A. dist. 55° 46′ 34″. (Co-dist. 34°.)

352·7 185·3	180·3 74·9
262·3	169·1
13′ 54″ 77·0	94·2
30	+0° 0′ 48″
−14 24	−0 14 22
3″ } +2″	−0 13 34
1 }	55 46 34
	TRUE DIST. 55 33 0 (19″ too small).

Ex. 3. A. alt. ☉ 60° 39′; A. alt. ☽ 34° 41′. ☉ corr. alt. 28″; ☽ corr. 43′ 40″. Hor. par. 54′ 47″; A. dist 43° 44′ 50″. (Co-dist. 46°.)

175·1 71·1	296·9 186·8
153·1	170·4
35′ 12 82·0	16·4
33	−0° 0′ 4″
−35 45 17″ } +12″	−0 35 33
5 }	−0 35 37
	43 44 50
	TRUE DIST. 43 9 13 (17″ too small).

It is evident from these examples, which, with those before given, exhibit a sufficient variety of cases, that the method is accurate enough for navigation in the open sea.

844. Method II. *By Logarithms.*—Set down in order the sun's or star's app. alt., the moon's app. alt., and the app. dist.; take half the sum, and subtract from it the first term in order (sun's or star's alt.); call the rem. the 1st rem.; subtract the second term in order (the moon's alt.), and call this rem. the 2d rem.

For the 1st Corr. To the log. cos. of the moon's app. alt. add the log. sine of the app. dist., the const. 9·6990, the log. sec. of the half sum, the log. cosec. of the 1st rem., and the prop. log. of the moon's corr. of alt.: the sum (rejecting tens) is the prop. log. of the 1st correction.

For the 2d Corr. Take the difference between the moon's corr of alt. and the 1st corr. Enter Table 56 with the app. dist. and the moon's corr. of alt., and take out the seconds. Enter again with the above difference, take out the corresponding seconds, and subtract them from those taken out before: the rem. is the 2d corr. Apply this corr. as directed in the table.

For the 3d Corr. To the log. cos. of the sun's (or star's) app. alt. add the log. sine of the app. dist., the const. 9·6990, the log. sec. of the half sum, the log. cosec. of the 2d rem., and the prop. log. of the sun's (or star's) corr. of alt.: the sum (rejecting tens) is the prop. log. of the 3d correction.

(As the 2d, 3d, and 4th logs. are common to the two corrections, it will be convenient to take the sum of these three logs.)

Subtract from the app. dist. the moon's corr. of alt. and the 3d corr.; add the 1st corr., the sun's (or star's) corr. of alt., and apply the moon's 2d corr. as directed in Table 56: the result is the true distance.

Ex. 1. App. alt. ☉ 47° 31; app. alt. ☽ 36° 52; app. dist. 48° 20′ 29″. Sun's corr. of alt. 47″; moon's corr. of alt. 45′ 35″.

☉ Alt.	47° 31′	....		cos.	9·8296
☽ Alt.	36 52	cos.	9·9031		
Dist.	48 20	sin.	9·8733		
	132 43		9·6990		9·9690
Half S.	66 21	sec.	0·3967		
1st Rem.	18 50	cosec.	0·4910		
2d Rem.	29 29	....		cosec.	0·3079
	45′ 35″	pr. log.	0·5965	47″ pr. log.	2·3613
1st Corr.	19 45	pr. log.	0·9596	3d Corr. 37″,	2·4678
Diff.*	26				

A. Dist. 48°, and ☽ Corr. Alt. 46′, Tab. 56, 16″
26 6
2d Corr. + 10

A. Dist.	48° 20′ 29″
☽ Corr. Alt.	− 45 35
3d Corr.	− 37
	47 34 17
1st Corr.	+ 19 45
☉ Corr. Alt.	+ 47
☽ 2d Corr.	+ 10
TRUE DIST.	47 54 59

Ex. 2. App. alt. ☉ 32° 36′, app. alt. ☽ 65° 22′, app. dist. 81° 15′ 51″; ☉'s corr. of alt. 1′ 22″, ☽'s corr. of alt. 22′ 27″: required True Distance.

1st Corr. 37″, 2nd Corr. 0, 3d Corr. 0, TRUE DIST. 80° 55′ 23″.

Ex. 3. App. alt. ✱ 50° 44′, app. alt. ☽ 27° 50′, app. dist. 93° 9′ 6″, ☽'s corr. of alt. 50′ 25″, ✱ corr. of alt. 47″.

1st. Corr. 4′ 45″, 2d Corr. 0, 3d Corr. 9″, TRUE DIST. 92° 24′ 4″.

* This diff. is the moon's corr. of dist. by the method No. 842. The sun's or star's corr. of dist. is found in like manner, thus: 47″ − 37″ = 10″ (agreeing within 1″).

[2.] *The Rigorous Method.*

845. In this method we find, by calculation, the true distance directly from the apparent distance and apparent altitudes.

(1.) Take both the app. alts. to the nearest even or odd minute, take their sum, and call the supplement of it the 1*st supplement.*

Subtract from this suppl. the moon's corr. of alt., and add to it the sun's or star's corr. of alt.; call the result the 2*d supplement.*

(2.) Take out the Logarithmic Difference, Table 73.

Take the app. dist. to the nearest even minute. Mark the seconds, if taken in *excess*, to be *subtracted*, or if *omitted*, to be *added* afterwards. To this add the 1st suppl., take the half sum, and from the half sum subtract the app. dist.

Add the log. sines of this half sum and remainder to the log. diff.; the sum (rejecting tens) is the log. sine square of an auxiliary arc x.

(3.) Under x put the 2d suppl., take the sum and the diff., and half the sum and half the diff.

Add together the log. sines of the last two terms; the sum is the log. sine square of an arc, which becomes the true distance on applying the reserved seconds.

Ex. 1. A. alt. ⊙ 47° 31′; app. alt. ☽ 36 52; app. dist. 48° 20′ 29″.
Sun's corr. of alt. 47″; moon's H. P. 58′ 35″; moon's corr. of alt. 45′ 35″

⊙ Alt.	47° 32′ 0″			
☽ do.	36 52 0			
	84 24 0		1st Sup.	95° 36′ 0″
			45′ 35″ + 47″,	− 44 48
			2d Sup.	94 51 12
☽ 36° 50′, H. P. 58′,				9·995792
2,			− 5	
		35″,	− 45	
⊙ 47°,			− 14	− 64
			Log. Diff	9·995728
A. Dist.	48° 20′ (29″ omitted)			
1st Sup.	95 36			
Sum	143 56			
Half S.	71 58		sine	9·978124
Rem.	23 38		sine	9·603017
x	75° 48′ 48″		sin. sq.	9·576869

x	75° 48′ 48″		
2d Sup.	94 51 12		
Sum	170 40 0		
Diff.	19 2 24		
Half S.	85 20 0	sine	9·998558
Half D.	9 31 12	sine	9·218363
		pts. for ″	149
	47 54 32	sin. sq.	9·217070
add	29		
Tr. Dist.	47 55 1		

846. It is useful to bear in mind, as a check against a gross mistake in clearing the dist., that the true and apparent distances cannot differ by more than the *sum* of the corrections of altitude. Again, when the moon's alt. is *equal* to, or *less* than, that of the other body, the true distance is *less* than the app. dist.; but the contrary does not always hold when the moon's alt. is the *greater*.

2. *Lunar Observation by the Sun.*

847. *The Observation.* (1.) The alts. of the sun and moon are required at the instant at which the distance is observed; when, therefore, the observer has assistants provided with proper watches, they will obtain the alts. during the time that he is observing the distance. See Nos. 560 and 561.

When the observer is alone, he will first observe the alt. of the body farthest from the meridian, then that of the other body, and then the distance; concluding with the alts. in the reverse order.* As precision is not necessary in the alts., one observation of the alt. will generally be enough at each time.

The time by watch is, of course, to be noted at each contact.

(2.) To observe the distance. Set the index nearly to the distance in the Nautical Almanac, at the nearest estimated Greenwich time; put down one or more shades to screen the central mirror, direct the sight to the moon, and, holding the plane of the instrument in the line joining the two bodies, vibrate it slowly round the line of sight as an axis till the sun's image is seen. Make a contact roughly, clamp the index, put in the telescope (previously adjusted to distinct vision by the moon), and complete the contact. See note §, p. 182.

The relative brightness of the object and image is most conveniently adjusted by altering the distance of the telescope from the plane of the sextant by means of the screw for the purpose, as this motion causes a greater or lesser quantity of light to proceed to the eye from the silvered or brightest part of the mirror.

Observe at least 3 or 5 distances, or, with the circle, 3 or 5 pairs.

When, at sea, the ship has much motion, the observer fixes himself firmly in a corner, or lies on his back on the deck, in order to remove, as much as possible, the sense of bodily effort and inconvenience which disturbs the eye and the attention.

(3.) For precision observe the moon's true bearing; if she is near the zenith, observe that of the star instead.

848. *The Computation* —(1.) Having reduced the alts. to the time of the mean of the distances, No. 660, find the Gr. Date. At sea, the Gr. Date is required only to the nearest hour; but if the moon's alt. is not observed, it must be found with precision. Reduce the hor. par., and thence the semid., from Table 40. Augment the semid., Table 42. For precision, correct the hor. par. by Table 41.

(2.) Find the App. Alts. of the centres by applying the ind. corr., dip, and semid.

Correct the observed distance for ind. error, and add the semidiameters of the bodies: the result is the *apparent distance*.

(3.) Find the Sun's Corr. of Alt. by subtracting the par. in alt. from the refraction. Find the Moon's Cor. of Alt. by Table 39. Correct for the therm. and barom. whenever these instruments are accessible. Tables 32, 33.

(4.) Find the true distance by No. 842, 844; or, for precision, No. 845, and apply the corrections, Nos. 852 and 853.

(5.) For the G.M.T. Find, in the Nautical Almanac, the two distances between which the true distance falls. Take out the first of these, and set it down under the true dist., and write against it

* The reason of this order, as a general rule in such cases, is, that the outer body preserves uniformity in its change of alt. for a longer time than the other, and consequently its alt. may be reduced, by simple proportion, to an intermediate time, with less error than the alt. of the other body. See No. 558.

its prop. log given in the Nautical Almanac; note also the time (that is, the three hours) corresponding.

Take the difference between the two distances thus set down, and from its prop. log. subtract the prop. log. taken from the Nautical Almanac; the remainder is the prop. log. of a portion of time to be *added* to the time from the Nautical Almanac. The result is the G.M.T. of the true distance.

For precision, see No. 856.

The G.M.T. being found, the long. is determined.

Ex. I. H M S. Eden, April 7th, 1831, lat. by acc. 34° 30′ S., long. 42° W., watch slow on the chron. 8h 16m 31s; chron. slow of G.M.T. 4h 54m 33s; height of eye, 16 feet; ind corr. −7′ 36″; had the following observations: required the error of the chronometer.

Times by Watch.	Alt. ☽	Alt. ☉	Distance.
12h 57m 24s	39° 2′		
12 58 36		47° 33′	
1 1 29			66 0′ 8″ (the mean of three sights.)
1 5 47		47 52	
1 8 18	36 42		

Reduction of the Altitudes to the time 1h 1m 29s.

☽ 39° 2′,	12h 57m 24s,	4m 5s	1·644
	1 1 29		
36 42,	1 8 18,	10 54	8·782
2 20			0·109
		−52′	0·535
		39 2	
Moon's Alt.		38 10	

☉ 47° 33′,	0h 58m 36s,	2m 53s	1·795
	1 1 29		
47 52,	1 5 47,	7 11	8·601
19			0·976
		+8′	1·372
		47 33	
Sun's Alt.		47 41	

Reduced Obs.—Time, 1h 1m 29s; Alt. ☽ 38° 10′; Alt. ☉ 47° 41′; Obs. Dist. 66° 0′ 8″.

Time by Watch	1h 1m
Watch slow of Chron.	8 16
Time of Obs. by Chron.	9 17
Chron. slow	4 55
	14 12
Gr. Date,* 7th	2 12

☽ H. P. on the 7th, noon,	56′ 34″
midnt.	56 59
Var. in 12h	25
Prop. Part for 2h, 4″, H. P.	56 38

Corresp. Sem. 15′ 26″; aug. do. 15 35″.

Obs. ☽		38° 10′
Ind. Corr.	− 8′	
Dip	− 4	
Sem.	−16	−28
☽ App. Alt.		37 42

Obs. ☉		47° 41′
Ind. Corr.	− 8′	
Dip	− 4	
Semid.	+ 16	+ 4
☉ App. Alt.		47 45

Obs. Dist.		66° 0′ 8″
Ind. Corr.	− 7′ 36″	
☽ Sem.	+ 15 35	
☉ Sem	+ 15 59	+ 23 58
App. Dist.		66 24 6

☽ App. Alt. 37° 40′, H. P. 56′,		43′ 5″
2 pts.	− 2″	
38	+ 30	+ 28
☽ Corr. of Alt.		43 33

☉ App. Alt. 48°, Refr.	53″
Par. in Alt.	−6
☉ Corr. of Alt.	47

Clearing the Distance (No. 842), to the End.

☽ Alt. 37½°, and Co-dist. 23½°

	M 137·5, N	33·4
☉ 47½ and 137·5	Dep.	101·4 (gr.)
	(Diff.)	68·0
☽ 1st Corr.		−29′ 37″
☽ 2d Corr. 44′, 8″ ; 30, 3	Corr.	+ 5″

☉ Alt. 47° and 23°, M 159·3, N 45·5

37 and 159		Dep. 95·7 (gr.)
		50·2
☉ Corr.	+0° 0 24	
☽ 2 Corrs.	−0 29 32	
	−0 29 8	
A. Dist.	66 24 6	
True Dist.	65 54 58	
Do. at 0h	67 0 8	p. log. ·3051
	1 5 10	p. log. ·4412
	2h 11m 35s	p. log. ·1361
T. of Pr. Dist.	0	
G.M.T.	2 11 35	

* In working by an approximate method, an expert computer will infer the Gr. Date at once, and perform many other parts of the computation with little or no writing

The watch being slow of the chron. $8^h\ 16^m\ 31^s$, the time of the obs. by the chron. is $1^h\ 1^m\ 29^s + 8^h\ 16^m\ 31^s$, or $9^h\ 18^m\ 0^s$; the chron. is therefore $7^h\ 6^m\ 26^s$ fast, or $4^h\ 53^m\ 35^s$ slow of the G.M T. Now, by Table 58, an error of 1 in the dist. causes, in this case, an error of $2^m\ 8^s$ in the G.M.T.; hence the result may be considered as confirming the error of the chron. nearly enough.*

Ex. 2. Sept. 28th, 1878, at $3^h\ 11^m\ 40^s$ P.M., M.T. at ship; in lat. 48° 50′ N., long. acc 146° 55′ W.; obtained the mean of 7 distances between sun and moon 34° 48′ 16″, obs. alt. ☉ 22° 37′, obs. alt. ☽ 18° 7′, height of eye 16 feet.

Gr. Date, Sept. $28^d\ 12^h\ 59^m\ 20^s$		
☽'s Red. H.P.		60′ 35″
Aug. Semid.		16 37
☉'s alt. 22° 49′	Ref.	2′ 18″
	Par.	−8
☉'s corr. of alt.		2 10

App. Dist.		35° 20′ 54″
☉'s App. Alt.		22 49
☽'s App. Alt.		18 20
18° 20′ H.P. 60		54′ 4
	35′	+ 33
☽'s Corr. of Alt.		54 37

Clearing the Distance by No. 844

☉ App. Alt.	22° 49	............................cos.		9·9646
☽ App. Alt.	18 20	cos.	9·9774	
App. Dist.	35 21	sin.	9·7624 ⎫	
	76 30		9·6990 ⎬	9·5664
Half Sum	38 15	sec.	0·1050 ⎭	
1st Rem.	15 26	cosec.	0·5749	
2d Rem.	19 55			cosec. 0·4677
Corr. Alt.	54′ 37″	P.L.	0·5179	2′ 10″ P.L. 1·9195
1st Corr.	41 34	P.L.	0·6366	3 Cor. 2 10 P.L. 1·9182
Diff.	13 3			

Dist. 35° 55′ Corr. 38″
13 2
2d Corr. + 36

App. Dist.	35° 20′ 54″	
☽ Cor. Alt. 54′ 37″ ⎫		
3d Corr. 2 10 ⎭	− 56 47	
	34 24 7	
1st Corr.	+ 41 34	
☉'s Corr. Alt.	+ 2 10	
2d Corr.	+ 36	
True Dist.	35 8 27	
At 12^h	34 34 33	P.L. 2417
	0 33 54	P.L. 7251
	$0^h\ 59^m\ 8^s$	P.L 4834
	12	
M.T.G.	28^d 12 59 8	
M.T.S.	28^d 3 11 40	
Long.	9 47 28	
	= 146° 52 W.	

Ex. 3. Sept. 1st, 1878, at $4^h\ 40^m\ 4^s$ P.M., M.T. at ship; lat. 3° 2′ N., long. acc. 1° 5′ W., obs. alt. ☉ 20° 0′, obs. alt ☽ 62° 30′, obs. dist. 61° 26′ 26″; height of eye 18 feet.

Gr. Date, Sept. $1^d\ 4^h\ 44^m\ 24^s$		
☽'s Red. H P.		59′ 38″
Aug. Semid.		16 31
☉'s Alt 20 12′	Ref.	2′ 37′
	Par.	− 8
☉'s Corr. of Alt.		2 29

App. Dist.		61° 58′ 51″
☉'s App Alt.		20 12
☽'s App. Alt.		62 42
62° 40′ H.P. 59′		26 36″
2	− 2 ⎫	
38″	+ 8 ⎭	+ 16
☽'s Corr. of Alt.		26 52

* The Nautical Almanac, before 1834, was computed for apparent time; the above result is therefore Greenwich app. time. This does not, however, in any way affect the value of a mere example.

Clearing the Distance by No. 844.

☉ App. Alt.	20° 12			......cos.	9·9724
☽ App. Alt.	62 42	cos.	9·6615		
App. Dist.	61 59	sin.	9·9459		
	144 53		9·6990		0·1653
Half Sum	72 26½	sec.	0·5204		
1st Rem.	52 14½	cosec.	0·1020		
2d Rem.	9 44½			cosec.	0·7716
Corr. Alt.	26′ 52″	P. L.	0·8261	2′ 29″ P. L.	1·8602
1st Corr.	31 59	P. L.	0·7549	3 Cor. 0′ 18″ P. L.	2·7695
Diff.	4 4′				

Dist. 62° 27 Corr. 4″
5 0
2d Corr. +4

App. Dist.		61°	58′	51″	
☽ Corr. Alt. 26′ 52″ / 3d Corr. 0 18		−	27	10	
		61	31	41	
1st Corr.		+	31	39	
☉'s Corr. Alt.		+	2	29	
2d Corr.		+	0	4	
True Dist.		62	5	53	
At 3ʰ		61	7	38	P.L. 2541
		0	58	15	P.L. 4900
		1ʰ	44ᵐ	33ˢ	P.L. 2359
		3			
M.T.G.	1ᵈ	4	44	33	
M.T.S.	1ᵈ	4	40	4	
Long.			4	29	
		= 1°	7′	15″ W.	

Ex. 4. Sept. 30th, 1878, at 4ʰ 54ᵐ 46ˢ P.M., M.T. at ship, lat. 17° 9′ S, long. acc. 102° 40′ W.; obs. alt. ☉ 16° 12′; obs. alt. ☽ 73° 14; obs. dist. 60° 22′ 59″; height of eye 16 feet.

G.M.T. Sept. 30ᵈ 11ʰ 35ᵐ 26ˢ, corr. H.P. 58′ 59″, aug. semid. 16′ 21″, ☉'s app. alt. 16° 24′, ☽'s app. alt. 73° 26′, app. dist. 60° 55′ 21″; ☉'s corr. of alt. 3′ 8″, ☽'s corr. of alt. 16′ 32″, true dist. 61° 10′ 36″. LONG. 102° 47′ 30″ W.

3. *Lunar Observation by a Star or a Planet.*

849. *The Observation.*—Take the alts. as directed, No. 847. In taking the distance, direct the view to the star, make the contact nearly between the star and the illuminated edge of the moon, whether it be the nearest or farthest limb; clamp the index, put in the telescope previously adjusted to distinct vision by the star, and complete the contact by bisecting or splitting the star upon the moon's limb.*

When the moon is bright, it is necessary to use a shade.

The setting of the index, No. 847 (2), is a more important step in observing with the star than with the sun, for the amount of distance is often the only security for employing the right star.

For precision, note the azimuth as directed No. 847 (3).

850. *The Computation.* (1.) Proceed by No. 848 (1). For a planet, take out the hor. par. from the Nautical Almanac, and reduce it.

(2.) Find the app. alts. as in No. 848 (2).

For the app. dist., correct the observed dist. for ind. error. When the *nearest* limb is observed, *add* the moon's semid.; when the *farthest*, *subtract* it.

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* It has been recommended to observe the star open of the moon's edge, leaving a dark space of about 40″. But this dark space will appear differently in different telescopes; and, moreover, it is better to be in the practice of observing accurately than loosely.

The inaccuracy which arises in bisecting a planet when it is not, as we should say of the moon, at the full, is but small; since, even in the case of Venus, the only planet which ever appears as a crescent when observed with the moon, it can scarcely exceed 6″ or 8″. It has been proposed to correct for this by a special computation.

(3.) Find the star's corr. of alt., which is the refraction. For a planet, apply the par. in alt. from Table 45. For the moon, take her corr. out of Table 39. For precision, correct for the height of the barom. and therm.

(4.) Find the true distance, and proceed as in No. 848 (4), to the end.

Ex. July 16th, 1826, near midnight, lat. by acc. 27° 5′ N., at $2^h\ 34^m\ 13^s$ by the chron., obs. alt. ☽ 35° 12′; obs. alt. Fomalhaut, 12° 51′; obs. dist. farthest limb, 70° 1′ 10″. Ind. corr. −20″; height of eye, 16 feet: required the error of the chron. supposed fast on G.M.T. $1^h\ 6^m\ 25^s$.

Time by chron.	$2^h\ 34^m$	H.P 16th, midnight	59′ 42″
Chron. fast.	1 6	17th, noon	59 35
G.D. 6th, past midnt.	1 28	Var. in 12^h	7
		Red. H.P.	59 41

Corresp Sem. 16′ 16″; Aug. do. 16′ 27″.

Obs. Alt. ☽	35° 12′	Obs. Alt. ✱	12° 51′	Obs. Dist.	70° 1′ 10″
Dip −4′ } Sem. +16 }	+12	Dip	−4	Ind. Corr.	−20
		✱ A. Alt.	12 47	☽ Sem.	−16 27
☽ A. Alt.	35 24			A. Dist.	69 44 23

35° 20′, and H.P. 59′,	46′ 47″	✱ Alt.	12° 47′
4, −2″ } 41″, +33 }	+31		
☽ Corr. of Alt.	47 18	✱ Corr. of Alt.	4 12″

Clearing the Distance (by No. 812) to the End.

☽ $35\frac{1}{2}$° and 20°, M 130·7 N. 26·0
✱ 13° and 131 Dep. 29·5 (gr.)
3·5
☽ 1st Corr. −1 36″
☽ 2d Corr. {47′, 6″ / 2, 0} +6

✱ 13° and 20°,	M 109·2	N. 8·4	
☽ 35° and 109		Dep. 62·5 (gr.)	
		54·1	
✱ Corr.	+0° 2′ 12″		
☽ 2 Corrs.	−0 1 30		
	+0 0 42		
A. Dist.	69 44 23		
True Dist.	69 45 5		
Dist. at Mid.	70 31 15	p. log.	·2747
	46 10	p. log.	·5909
G.M.T.	$1^h\ 26^m\ 55^s$	p. log.	·3162
T. by Chron.	2 34 13		
Error, *fast*	1 7 18		

Ex. 2. Sept. 7th, 1838, P.M., lat. 3° 2′ N., long. $4^h\ 0^m$ W., at $12^h\ 57^m\ 8^s$ by watch, obs. five distances of the moon's nearest limb from Aldebaran, 27° 47′ 12″. App. alt. ✱ 26° 32′; app. alt. ☽ 53° 34′; watch slow $9^m\ 17^s$ of M.T.; ind. corr. −1′ 10″: required the longitude.

☽ red. H.P. 59′ 48″; true dist., by No. 815, 28° 37′ 17″; dist. at XV^h, 29° 47′ 47″.
LONG. 59° 56′ W.

Ex. 3. Sept. 2d, 1840, P.M., lat. 3° 2′ N., long. 60° 0′ W., at $8^h\ 48^m\ 39^s$ by watch, obtained the mean of 5 distances between Saturn and the moon's nearest limb, 89° 42′ 55″; ind. corr. −1′ 25″; watch slow of M.T. $7^m\ 33^s$; app. alt. ☽ 53° 3′; app. alt. Sat. 23° 34′.

☽ red. H.P. 60′ 44″; true dist., by No. 815, 89° 56′ 11″; dist. at III^h, 89° 1′ 31″.
LONG. 60° 1′ W.

Ex. 4. July 14th, 1878, at $2^h\ 10^m\ 0^s$ A.M., M.T. at ship, lat. 22° 0′ S., long. acc. 147° 30′ E., obs. alt. Antares 19° 33′, obs. alt ☽ 51° 48′, obs. dist. near limb 75° 22′ 49″, height of eye 24 feet

G. M. T. July $13^d\ 4^h\ 12^m$, corr. H.P. 56′ 41″, aug. semid. 15′ 29″, ✱ app. alt 19° 28′, ☽'s app. alt. 51° 59′ app. dist. 79° 38′ 18″, ✱ corr. 2′ 44″, ☽'s corr. 34′ 9″, true dist. 79° 29′ 41″. Long. 149° 33′ E.

Ex. 5. June 19th, 1878, at $4^h\ 30^m$ A.M.; M.T. at ship, lat. 20° 10′ N., long. acc. 75° W., obs. alt. Venus 23° 14′, obs. alt. ☽ 52° 54′; obs. dist. near limb 86° 45′ 44″, height of eye 16 feet.

G.M.T. June $18^d\ 21^h\ 30^m$, corr. H P. 55′ 7″, aug. semid. 15′ 14″, Venus' app. alt. 23° 10′, ☽'s app alt. 53° 5′; app. dist. 87° 0′ 58″, Venus' corr. 2′ 9″, ☽'s corr. 32′ 23″. true dist. 86° 43′ 48″. Long. 75° 6′ 15′ W

4. *Special Corrections.*

851. When precision is required, it is necessary, besides removing from the distance the general effects of refraction and parallax, to apply certain corrections.

[1.] *Correction for the Elliptical Figure of the Disc.*

852. Since the refraction of each point of the disc of the sun or moon is greater as the alt. of such point is less, and since the change of refraction is proportional to small changes of alt., the upper and lower halves of the circular disc take more or less the figures of ellipses, the lower half being more flattened than the upper half. The distance, therefore, between the centre and the limb, as it would actually be observed, is less than the horizontal semidiameter of the Tables. The elliptical figure of the sun, due to this cause, is often conspicuous at rising and setting. The correction in Table 53 is to be subtracted from the semidiameter.*

[2.] *Correction for the Spheroidal Figure of the Earth.*

853. The true distance found from the data, as above, is deduced on the supposition that the earth is a sphere, instead of a spheroid. The true distance found is, in fact, that corresponding to a sphere of smaller dimensions than those circumscribed by the equator,† and to an horizon differently placed with respect to the equator, or to another latitude than that of the spectator.

Since, however, the mere change of the place of the spectator would cause no alteration in the apparent angular distance of two stars, the change of distance arises solely from the variation of the apparent place of the moon, produced by the changing of the observer's astronomical latitude for the geocentric latitude. The change of place of the moon is thus in general the resultant of a change both of her altitude and her azimuth.

This correction is 0 at the equator and poles, and is greatest in lat. 45°. As it cannot much exceed $\frac{1}{60}$ of the reduction of latitude, it may in practice be omitted, but the effect rarely disappears altogether.

* We have not applied this correction, because at low altitudes, the only case in which it is sensible, the observation is not to be depended upon within such small quantities.

† The correction on this account has already been made in the reduction of the moon's equatorial parallax.

854. To correct the distance.

Enter Table 55 with the lat. and the alt. 90°, and take out the number.

For Part I. Enter Table 5 with the complements of the moon's azimuth and of the angle at the moon (found by No. 842 or 844),* and take out M. Divide the number by M.

For Part II. Enter Table 5 with the moon's azimuth and the angle at the moon, and take out M. Divide the number by M.

The quotients are in seconds, and are to be applied to the distance as follows.

Note —The observer is supposed to face the moon, and the azimuth is reckoned from the S. in N. lat., and from the N. in S. lat.

	Part I.				Part II.		
	In N. Lat.		In S. Lat.			Azimuth of the ☽	
	Sun or Star		Sun or Star				
	to the *right*	to the *left*	to the *right*	to the *left*		less than 90°	*greater* than 90°
☽ to the Eastward	sub.	add	add	sub.	Angle at the ☽ *less* than 90°	sub.	add
☽ to the Westward	add	sub.	sub.	add	Angle *greater* than 90°	add	sub.

Ex. Lat. 48° N.; moon's alt. 30°; star's alt. 61°; dist. 54°; **moon's azim. S. 72° E.**; and the star to the right.

The angle at the moon is 34°.

The number in Table 55 is 1100.

Co-az. 18°, Co-ang. 56°, M 188·0

$\frac{1100}{188} = 6''$, *subtractive.*

Az. 72°, Ang. 34°, M 390

$\frac{1100}{390} = 3''$, *subtractive.*

Hence the Correction is $-9''$.

855. When the moon is near the zenith, or when her alt. exceeds 80°, with the lat. and the compl. of the star's azimuth as an altitude, take out the seconds from Table 57, and divide them by 100; the quotient is the correction required in seconds.

When the star's azim. (reckoned as above) is *less* than 90°, *subtract* the corr., otherwise add it.

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* Since the angle at one or both bodies, which is given by the method No. 842, is necessary in making the corrections, No. 852, 853, and since that method affords both an approximation by which the long. by acc., if greatly in error may be corrected, and at the same time a check against any important error in the rigorous process itself, it will be advisable to employ it on all occasions.

The angle at the body may be found from No. 844, when that method is employed, thus:—Take the sum of the logs., rejecting the const 9·6990 and the prop. log.; the ar. co log. of this sum is the log. sine square of the angle required.

Ex. No. 844.

Sum of four logs.		0·6641	Sum of logs.		0·4075
Angle at ☽ 55 30	sin. sq.	9·3359	Angle at ⊙ 77° 12′	sin. sq.	9·5925

[3.] *Correction for the Inequality of the Moon's Motion.*

856. Since the moon does not generally change her distance from the sun or a star at the same rate, both at the beginning and end of 3 hours, it is often proper to apply a correction to the Gr. M.T. found, which, in the extreme case, may be in error 50′ of long.

When the distance exceeds 26°, this correction will not exceed 15′ of long.; when the distance is near 90°, it will not exceed 2′. In general, it is smallest in the case in which the sun or star is in a direction perpendicular to the line of cusps or horns.

857. Take the diff. between the prop. logs. in the Nautical Almanac against the two distances between which the given true dist. falls. With this diff., and the portion of time found in No. 848 (5), enter Table 57, and take out the seconds. When the prop. logs. in the Nautical Almanac are *increasing*, *subtract* these seconds; when *decreasing*, *add* them; the result is the M. T. at Greenwich, corrected.

Ex. 1. Dist. in Naut. Alm., preceding given dist.,

	22° 58′ 21″	prop. log.	3079
following do.	24 56 56	do.	3054 (*decreasing*)
		Diff.	25
Diff. 25 under Int. 13ᵐ, (*add*)	0^h 0^m 2^s		
	0 26 9		
CORRECTED G. M. T.	0 26 11		

Ex. 2. In Ex. 2, No. 850, dist. 29° 47′ 47″ has the prop. log. 2527; the next in order has 2581; the diff. 54 gives 14^s to be *subtracted*; and the long. corrected, 59° 52′ W.

858. *Degree of Dependance.* The true distance is affected by errors of observation, and by errors of computation. An error in the distance, of whatever kind, produces, on the average, about 30 times its amount in the longitude; thus, 10″ error of distance produce about 300″ or 5′ error of longitude.

The observed distance is liable to the ordinary errors of angular distance, the chief of which are, perhaps, most usually that due to defect of parallelism of the telescope, and that arising from making the contact above or below the centre of the field. Irradiation is also included in the errors of observation.

859. The error of the computed result arises from two sources; the errors in the elements of the observation, and those of the method of solution

(1.) Under the first of these heads are comprised the errors in the horiz. par. in reducing it to the Gr. Date, and for the figure of the earth, the error of the tabular semidiameter;* and that of refraction in low altitudes.

(2.) The effects of errors of a few minutes in the altitude are insensible. Hence an ill-defined horizon is no great detriment to a

* The Greenwich observations shew that the semidiameter of the moon, as given in Burckhardt's tables, is 3″ too small.—See "Green. Obs." 1837.

good observation; and hence, also, in computing the altitudes, precision is not essential. This last remark is worth attention, since the calculation of altitudes is a heavy addition to the work of a lunar. On the same account it will not be necessary to consider the change of place during the observation, unless the second alt. of either body be lost.

(3.) The importance of correcting for the barometer and thermometer has been noticed, No. 838. The atmospherical correction is of most consequence at low altitudes, and when the bodies are in or near a vertical plane.

(4.) The smaller corrections, namely, reduction of equatorial parallax, corrections for elliptical disc, for the figure of the earth, and for unequal motion, cannot all be applied the same way in any observation; compensation will accordingly take place to a considerable extent even when these corrections are omitted altogether. It will, however, be advisable to apply the latter correction, No. 856, when large.

860. The error of the method of solution, No. 842, may be estimated for distances exceeding 50° at not more than 20″, in general, or 10′ of long.

Method II., No. 844, will, in the same cases, be more accurate.

861. The effects of errors in general, and especially constant errors of observation, are removed in a considerable degree by observing *equal distances* on *opposite sides* of the moon, since the errors of the resulting longitudes will be of opposite kinds. The true long. will not, however, be the *mean* of the two erroneous longitudes, unless the moon changes her distance from both bodies at the same rate.

When the two longitudes in such a case differ widely, add the prop. log. of their difference in time to the prop. log. of the *greater* motion in 3 hours (which is the *smaller* of the prop. logs. in the Nautical Almanac), and the ar. co. prop. log. of the sum of the two 3-hourly motions; the sum is the prop. log. of a portion of the time to be applied to the long. obtained by the star whose prop. log. is employed.

Since the true long. must fall between the two given results, it will be known at once whether to add or subtract.

When the sum exceeds 3°, read the degr. and min. as min. and sec.

Ex. The long. by Regulus, in a certain case of a lunar, is $2^h\ 37^m\ 15^s$; by Antares, $2^h\ 40^m\ 58^s$; the distances being nearly equal on opposite sides, and observed by the same observer with the same instrument. The 3-hourly motion of Regulus is 1° 45′ 31″, that of Antares 1° 30′ 29″: required the True Long.

Long. Reg.	$2^h\ 37^m\ 15^s$	3-hour. mot.	1° 45′ 31″	p. l. (1′ 45″)	2·0101
Ant.	2 40 58	do.	1 30 29		
			3 16 0	ar. co. (3′ 16″)	8·2588
	3 43	....		p. l.	1·6851
			$0^h\ 2^m\ 0^s$	p. l.	1·9540
			2 37 15		
		Long. req.	2 39 15	(9ˢ more than the mean).	

862. After the result has been obtained with the utmost care, there remains the error of the lunar tables, which appears to be about $0^s\cdot5$ of R.A., or 4′ of long. This can be removed only by careful examination of observations of the moon, made near the same time in a fixed observatory. In general, the result will have more value as the moon's horizontal parallax is greater, because her motion is then more rapid; on the contrary, the result is of less value as the horiz. par. is less. Since the changes of the moon's R.A., at their maximum and minimum, are nearly in the ratio of 5 to 3 and since the change of R.A. is in a considerable degree, though not in exact proportion, greater as her distance from the earth is less, it is evident that the place of the moon at the time of observation materially affects the value of the result.*

5. *Computation of the Altitudes.*

863. When the altitudes are not observed they must be calculated. M.T. is supposed to be given.

(1.) Reduce to the Gr. Date the sid. time at mean noon, also the R.A. and decl. of each body, unless one of them is the sun, in which case reduce the equat. of time instead of his R.A.

(2.) Find the hour-angles, Nos. 609 to 612, and compute the alt. of each body, No. 667. See No. 859 (2).

For the *apparent* altitudes. Take out the corrections of altitude to the true alts., found as if for app. alts., to the nearest minute, and apply these corrections the *contrary way* to that directed in the rules, Nos. 644, &c.†

Ex. Sept 11th, 1838, A.M., at Fort St. Joaquim, lat. 3° 2′ N., long. $4^h\ 0^m$ W., at $9^h\ 49^m\ 40^s$ by watch, obtained the mean of five distances of the sun and moon, 82° 16′ 51″. Ind. corr. − 55″; watch fast of M.T. $3^m\ 2^s$; therm. 85°; barom. 29·7 inch.

T. by watch	$9^h\ 49^m\ 40^s$	☽ H. P. 11th, noon	56′ 56″
Watch fast	− 3 2	midn.	56 32
	9 46 38		0 24
M.T.	21 46 38		0 3
Long W.	4 0 0		56 56
Gr. Date, 10th,	25 46 38	Red. H. P.	56 53
or 11th,	1 46 38	Semid.	15 30

* In combining the results of different observations for the purpose of deducing the longitude of a place, regard would be had to this and other circumstances in giving a different weight to each several result. The final determination of positions, however, by means of observations made at different times and under different circumstances, concerns the hydrographer or geographer rather than the seaman or traveller, and is not a subject for this volume.

† As the altitudes in a lunar are not required with precision, Tables 43 and 44, which are necessary to remove the inaccuracy of using the true alts. as arguments, will rarely be employed.

It will be prudent to verify the result by the method of inspection (see Expl. of Table 5), in order to avoid entailing any material error on the whole of the subsequent computation.

Elements for computing the Altitudes.*

Sid. T. noon		$11^h\ 20^m\ 14^s$
1^h, 10^s		
$46^m\frac{1}{2}$, 7		17
Red. S. T.		11 20 31
M. T.		21 46 38
		33 7 9
Eq. of T.	11th,	$3^m 23^s$
	12th,	3 44
		21
Red. Eq. T.		3 24

M. T.	$21^h\ 46^m\ 38^s$
	+ 3 24
	21 50 2 W.
☉ H.-ang.	2 9 58
☉ Decl.	4° 38′ 38″ N.
	4 15 45 N.
	22 53
	1 40
	4 38 38
Red. Decl.	4 36 58 N.
P. Dist.	85 23

☽ R. A. 11th, 1^h,		$5^h\ 41^m\ 14$
2,		5 43 42
		2 28
		9·5229
	$2^m 28^s$	1·5632
	46 38	0·5866
	$0^h\ 1^m 55^s$	1·9727
	5 41 14	
Red. R. A.	5 43 9	
	33 7 9	
☽ H.-A.	3 24 0	
☽ Decl.	28° 36′ 48″ N.	
D. 13″	1	
☽ Decl.	28 38	
P. Dist.	61 22	

Computation of the Altitudes.

☉ H.-A.	$2^h\ 9^m\ 58^s$		
Suppl.	9 50 2	sin. sq.	9·96461
P. D.	85° 23′	sine	9·99859
Col.	86 58	sine	9·99939
	172 21		
Arc x	146 36	sin. sq.	9·96259
	318 57		
	25 45		
	159 28	sine	9·54500
	12 53	sine	9·34824
	32° 29′	sin. sq.	8·89324
☉ Tr. Alt.	57 31		
Corr. Alt.	+ 1		
☉ A. Alt.	57 32		

☽ H.-A.	$3^h\ 24^m\ 0^s$		
Suppl.	8 36 0	sin. sq.	9·91098
P. D.	61° 22′	sine	9·94335
Col.	86 58	sine	9·99939
	148 20		
Arc x	115 21	sin. sq.	9·85372
	263 41		
	32 59		
	131 50	sine	9·87221
	16 29	sine	9·45291
	54° 45′	sin. sq.	9·32512
☽ Tr. Alt.	35 15		
Corr. Alt.	− 46		
☽ A. Alt.	34 29		

	82° 16′ 51
	− 55
	82 15 56
	+ 15 55
	+ 15 50
	+ 9
A. Dist.	82 47 50

☉ 57° 32′,	37″
	− 5
85°, −2″	32
2, 0	− 2
☉ Corr. of Alt.	30

☽ 34° 20′, H. P. 56′,		44′ 50″
9	− 4″	
53″	+ 43	+ 39
		45 29
85°, − 5″		
− 1		+ 6
☽ Corr. of Alt.		45 35

Proceeding to clear the distance by No. 845, the log. diff. is 9·996092, and the true dist. 82° 4′ 51″. The next dist. preceding is 82° 58′ 33″, at noon; and the G. M. T. $1^h\ 47^m\ 0^s$, or Long. 60° 5′ 30″ W.†

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* To adapt this form for computing the altitudes to the case of a planet, put the planet's hor. par. in the place of the equat. of time; and in the next column the planet's R. A.

† This observation, and those in Examples 2 and 3 of No. 850, were taken, with several others, by Sir Robert Schomburgh, to whom I am indebted for them.

III. By the Moon's Altitude.

864. Since Mean Time is determined by the hour-angle and R.A. of a celestial body, the R.A. may be determined from the M.T. and the hour-angle, the latter being computed from the observed altitude. Now the moon's R.A. being given in the Nautical Almanac for certain points of time, the time at Greenwich corresponding to any given R.A. of the moon may be at once found.

The moon's altitude has accordingly been often thus employed in determining the longitude; but the method requires much caution, because an error of altitude produces, in the hour-angle computed from it, a quantity greater than itself, except in the single case in which the observer is on the equator and the body on the prime vertical, when these errors are equal. Accordingly, since an error in the moon's hour-angle appears in its full amount in her deduced R.A., and since the R.A. changes at the rate of about 2^m only in an hour, the longitude required is vitiated to the extent of not much less than thirty times the error of altitude in the most favourable cases.

It is evident, therefore, since the place of the sea-horizon is often doubtful from 1′ to 3′, that the result of a simple lunar altitude must be in general greatly inferior to that of a lunar distance, in which a good observer rarely makes an error exceeding half a minute. But as many persons, who are not sufficiently expert in the lunar observation to obtain on all occasions a satisfactory longitude, are nevertheless capable of observing altitudes with precision, and, moreover, as the stars, when the air is not very clear, are often too faint for the lunar observation, the former method may, on some occasions, prove of service, provided that proper steps are taken to diminish the effects of the errors of latitude and altitude.

Since on the equator, when the body is E. or W., an error of 1′ in alt. produces an error of 4^s in the hour-angle, and an error of 8^s in lat. 60° (or in the ratio of the secant of the latitude to 1), the method serves better in low than in high latitudes.

If the resulting longitude differs much from the long. by account, the computation should of course be repeated.

865. *Limits.* The azimuth is the same as that laid down for determining the time by a single altitude, No. 778. The alt. should in general not be less than 6° or 8°; and when the barometer and thermometer are not at hand, not less than 25° or 30°, especially in very cold or very hot weather.

866. *The Observation.* Observe the moon's alt., noting the time.

If the mean time is not accurately known, obtain observations for it.

At sea, the uncertainty of the apparent dip may be removed by referring the moon's altitude to the opposite point of the horizon, as well as to that under her (No. 535).

But it will be preferable to observe the *difference* of alt. of the moon and some star on nearly the same bearing, and to apply it to the star's alt. found by computation; for the time may sometimes be more nearly known than the lat., and the alt. of a star computed more nearly than it can be observed.

For Ex. Suppose, in lat. 40°, the ☽ bearing E.S.E. (true), that the place of the sea horizon is 1′ 30″ in error, and the time in error 5^s. Then the error of the ☽'s computed hour-angle (and therefore of her R.A.) will be 9^s (No. 671), and the resulting error of long. about $4^m\ 30^s$, or 1° 4′ (Nos. 858, 864). Now the error of the computed alt. of a star E. or W. due to an error of 5^s will here be 56″ (No. 671); hence the error of the long., as determined by the moon's alt. referred to this star, will be diminished in the proportion of 1′ 30″ to 56″, that is, from 64′ to 40′.

867. *The Computation.* (1.) Find the Gr. Date, and reduce to it the Sid. T. at mean noon, the moon's decl., and thence her pol. dist., her hor. par., and semidiameter; correct the hor. par. by Table 41.

(2.) Add the M.T. to the red. Sid. T.; the sum (rejecting 24^h if it exceed 24^h) is the R.A. of the meridian.

(3.) Correct the alt.*

(4.) Compute the moon's hour-angle, No. 614.

(5.) When the moon is to the E. of the meridian, *add* her hour-angle to the R.A. of the mer. If the sum exceed 24^h, reject 24^h. When to the W., *subtract* the hour-angle from the R.A. of the mer., increased, if necessary, by 24^h: the result is the moon's R.A.

(6.) For the G. M. Time. Set down in order this R A., that preceding it, and that following it (from the Nautical Almanac); take the diff. between the 1st and 2d, and between the 2d and 3d, adding 24^h, if necessary, to effect the subtraction.

To the constant 0·4771 add the prop. log. of the first of the diffs. and the ar. co. prop. log. of the 2d; the sum is the prop. log. of a portion of time to be *added* to the hour at Green. of the middle one of the three right ascensions: the sum is the G. M. T.

Ex. 1.† Jan. 5th, 1839, lat. 4° 54′ 0″ S., long. by acc. 33° 13′ W., at $20^h\ 56^m\ 40^s{\cdot}8$ M.T., obs. alt. ☽ 30° 6′ 20″ to the W.; ind. corr. −35″; height of eye, 12 feet; therm. 82°, barom. 30·0 inches: required the longitude.

M. T.	$20^h\ 56^m\ 41^s$	☽ Decl. 5th, at 23^h, 0° 16′ 39″ S.		H. P. 5th, Mid.	54′ 25″·2
33° 13′ W.	+ 2 12 52	Diff. for 10^m, 142″		6th, Noon	54 18 ·0
Gr. D.	23 9 33		0° 16 39″	Var. in 12^h	7 ·2
Sid. T. 5th,	18 57 34·8	140″, 9^m, 2′ 6″		7″·2 and $11\frac{1}{4}^h$,	0 6 ·8
23^h	3 46·7	33^s 7·7			54 25 ·2
9^m	1·5	2 $9\frac{1}{2}^m$ 1·9	2 16	Equat H. P.	54 18 ·4
33^s	·1	Red. Decl.	0 18 55 S.	Corr. Table 41	0
Red. S. T.	19 1 23·1	Pol. Dist.	89 41 5	Corr. Semid.	14 48
M. T.	20 56 40·8			Augm.	7
R. A. Mer.	15 58 3·9			Aug. Sem.	14 55

* It cannot be worth while to follow the 2d and 3d precepts of No. 655, unless the observation is in every respect such as to afford extreme precision in the result.

† These examples are selected from observations made by Mr. J. C. Bowring on board H. M. S. Stag, with which I have been favoured by Mr. Pentland, her Majesty's late consul-general at Bolivia.

Obs. Alt. ☽		30° 6′ 20″
Ind. Corr.	−0′ 35″	
Dip.	−3 20	−3 55
		30 2 25
		−14 55
App. Alt.		29 47 30
19° 40′ and 54′	45′ 14″	
7 *sub* 3′		
18″ *add* 16	+13	
	45 27	
Th. 82° *add* 6		
Par. 30 0	6	+45 33
True Alt.		30 33 3

Alt.	30° 33′ 3″		
Lat.	4 54 0	sec.	0·001590
P. Dist.	89 41 5	cosec.	0·000007
	125 8 8		
	62 34 4	cos.	9·663417
	32 1 1	sin.	9·724415
Hour-ang.	3h 57m 25s·2	sin. sq.	9·389429
	15 58 3·9		
R. A. ☽	12 0 38·7		0·4771
At 23h,	12 0 23 9	0m 14s·8	2·8632
0,	12 2 8·3	1 44·4	7·9853
	0h 8m 30s·3		1·3256
	23		
G. M. T.	23 8 30·3		
M. T.	20 56 40·8		
LONG.	2 11 49·5 or 32° 57′ W.		

An error of 1s of R. A. would produce here 34s or 8½′ error of long., as the R. A. changes very slowly. An error of 1′ of alt. would cause 4s of R. A. and 34′ of long., and an error of 1′ of lat. only 0s·1 of R. A. The moon's azim. is 87°.

Ex. 2. Jan. 23d, 1839, lat. 20° 57′ 10″ N., long. by acc. 42° 39′ W., at 3h 32m 10s M. T. obs alt. ☽ 42° 25′ 28″ to the E. Ind. corr + 1′ 37″; height of eye, 12 feet; required the Longitude.

Gr. Date, 23d	6h 22m 46s	Red. Decl.	21° 42′ 15″ N.	Equat. H. P.	58′ 42″·1
Red S. T	20 9 35·7	Pol. Dist.	68 17 45	Red. do.	58 40·8
R. A. Mer.	23 41 45·7			Corresp. Sem.	16 0
				Aug. Sem.	16 11

☽ Corr. of Alt.	42′ 26″	Hour-angle	3h 23m 27s·0
☽ True Alt.	42 50 10	☽ R. A.	3 5 12·7
		Do. at 6h	3 4 20·2
			3 6 41·8
		G. M. T.	6h 22m 15s
		LONG.	2 50 5 or 42° 31′ W

An error of 1s of R. A. produces here 25s, or 6′ error of long.; an error of 1′ of alt. produces 4s·3 error of R. A., or 27′ of long.; and an error of 1′ of lat. causes 0s 9 of R. A., or 5′ of long.

868. When two or three observations are taken on the same side of the meridian and prime vertical, the true long. is not the mean of the results, but is nearer to that which is furthest from the meridian.

When two observations are taken on opposite sides of the meridian and on the same side of the prime vertical, the right ascensions resulting will be affected in different ways by the same errors of altitude and latitude, and the true long. will be between the two results.

869. *Degree of Dependance.* This is determined by the effects produced on the hour-angle by given errors in the alt., lat., and pol. dist., No. 615. It is evident, from the remarks above, that unless considerable care, and some skill, are devoted to diminishing, according to the circumstances of the case, the effects of errors of latitude and altitude, it cannot be prudent, notwithstanding the occasional success of observations of this kind, to depend upon the result as nearer than ½ of a degree.

On shore, when the lat. and time are accurately known the result may, with proper attention, be more satisfactory.

No. 862 applies to this observation.

IV. By an Occultation.

870. The moon in her perpetual revolution round the earth necessarily passes over every star or other body in her path at certain periods. The disappearance of a star or planet, called the *immersion*, and the reappearance from behind the body of the moon, called the *emersion*, being instantaneous, the phenomenon affords the means of determining the longitude at all places where it is visible.

At the instant of occultation the apparent R. A. of the moon's limb is the same as the R.A. of the star; the effect of the parallax of the moon being removed by computation, the true R.A. is deduced, and the G.M.T. thence found.

871. This observation affords, in favourable cases, the most decisive results, because it is both instantaneous and altogether independent of instrumental adjustments. On board ship the motion prevents the telescope, which is almost always necessary, from being kept steadily directed to the moon, and in consequence the method has been very rarely practised at sea. The precise instant of the phenomenon is, however, not necessary in all cases; it is enough that the observer is certain that at one instant he sees the star, and that at another he does not see it; because the whole resulting error in the time of observation in this case, and therefore in the longitude itself, cannot exceed the time elapsed between two sights of the moon.

872. The M.T. at Greenwich, at which the moon and the star to be occulted are in conjunction in R. A., is set down in the Nautical Almanac, as also the parallels between which the phenomenon is visible.

As it would require a distinct calculation to learn beforehand approximately the time at which the phenomenon will take place, the observer may content himself with finding, from the long. by acc., the time at place of the conjunction; he must then, at an early opportunity, single out the star, and watch the progress of the moon towards it. In general, when the star is to the *eastward* of the observer at the time of conjunction, the phenomenon occurs *before* that time; when to the *westward*, it occurs afterwards.

1. *Occultation of a Star.*

873. *The Observation.* Note the instant of immersion or emersion as nearly as possible.

874. *The Computation.* (1.) Find the Green. Date, and reduce to it the Sid. Time at mean noon, the moon's declination, hor. par., and semid.; reduce the hor. par. by Table 41.

(2.) Find the geocentric latitude by subtracting from the lat. the reduction of lat., Table 52. From the time at place find the star's hour-angle, No. 611.

(3.) For arc A. To the prop. log. of the reduced hor. par. add the log. cosec. of the geocentric lat. and the log. sec of the star's decl.: the sum is the prop. log. of arc A.

For arc B. To the prop. log. of the red. hor. par. add the log. sec. of the geoc. lat., the log. cosec. of the star's decl., and the log. sec. of the hour-angle: the sum is the prop. log. of arc B.

For arc C. Add together the prop. log. of the red. hor. par., the log. sec. of the geoc. lat., and the log. cosec. of the hour-angle; double the sum, add to it the const. 1·582, and the log. cot. of the star's decl.: the sum is the prop. log. of arc C.

(4.) When the lat. and decl. are of the *same* name, *add* A to the star's decl.; when of *contrary* names, *subtract* it.

When the star's hour-angle is *less* than 6^h, subtract B from the star's decl.; when *greater* than 6^h, *add* it

Subtract C from A.

Call the result the prepared declination.

(5.) For Part I. of the ☽'s Parallax in R. A. Take the diff. between the moon's decl. and the prepared decl.; under this diff put the semid.: take the diff. and sum. Add together the log. cos. of the prepared decl., the const. 1·1761, half the prop. logs. of the diff. and sum: the sum is the prop. log. of Part I.

For Part II. Add together the log. cos. of the prepared decl., the const. 1·1761, and the sum of the 3 logs. used in arc C: the sum is the prop. log. of Part II.

When the moon is on or near the meridian, this Part disappears.

(6.) Apply Parts I. and II. to the star's R. A., thus:—

Part I. In an *immersion*, *subtract*; in an *emersion*, *add*.

Part II. When the ☽ is to the E. of the Mer., *subtract*; when W., *add*. The result is the moon's R. A.

(7.) Find the G.M.T., as directed, No. 867 (6.)

Ex. Dec. 9th, 1823, lat. 9° 40′ S., long. by acc. 29° 51′ W., at $7^h\ 19^m\ 57^s$ M.T., observed the immersion of κ Aquarii,* W. of the meridian: required the longitude.

Gr. Date, 9th	$9^h\ 19^m\ 23^s$	✱ Decl.	5° 7′ 43″·6 S.	Red. Eq. H. P.	54′ 38″·07
Red.S.T. at m. n.	17 11 13·7	☽ Red. Decl.	5 16 22·6	Red. H. P.	54 38·04
M.T.	7 19 57			Semid.	14 53·4
	24 31 10·7			Lat.	9° 40′
Star's R A.	22 28 39			(Tab. 52) Cor.	−3 41
Hour-angle	2 2 31·7				9 36 19
Arc A.		Arc B.		Arc C.	
H.P. 54′38″ p. log.	0·5178	....	0·5178	....	0·5178
Geoc. Lat. cosec.	0·7777	sec.	0·0061	....	0·0061
✱ Decl. sec.	0·0017	cosec.	1·0487	Hour-angle cosec.	0·2928
P. log.	1·2972	Hour-angle sec.	0·0653		0·8167
A,	+9′ 4″·8	P. log.	1·6379		0·8167 × 2 = 1·6334
B & C, −	4 8·8	B, − 4′ 8″·5		Const.	1·5820
	+4 56·0	(Hour-angle *less* that 6^h subtract.)		✱ Decl. cot.	1·0469
(Decl. S. lat. S. add.)				C, 0″·3 p. log.	4·2623

* This occultation, kindly furnished me by the Hon. Capt F. De Ros, R.N., is given as having been observed by him, at sea, in H.M. frigate Creole.

Part I.

✱ Decl.	5° 7′ 43″·6		
Prep. Decl.	5 12 29 ·6	cos.	9·9982
☽ Decl.	5 16 22 ·6	const.	1·1761
	3 43		
Semid.	14 53 ·4		
Diff.	11 10 ·4	½ pro. log.	0·6035
Sum.	18 36 ·4	½ pro. log.	0·4928
	−0 57 ·9	pro. log.	2·2706

(*Subtract*, being *immer.*)

Part II

Cos. of Prep. Decl.			9·9982
Const.			1·1761
Sum of 3 logs. Arc C.			0·8167
Pt. II.	+ 1^m 50^s·2	p. log.	1·9910
Pt. I.	−0 57 ·9		
	+ 52 ·3		
✱ R.A.	22 28 39		
☽ R.A.	22 29 31 ·3		4771
At 9^h	22 28 55 ·7	0′ 35″·6	2 4820
At 10^h	22 30 45 ·1	1 49 ·4	8·0060
	0 19 30 ·3	p. log.	9657
	9		
G.M.T.	9 19 30 ·3		
Ship M.T.	7 19 57		
Long. in time	1 59 33 ·3	or 29° 53′ 19″ W.	

Ex. 2. Jan. 7th, 1836, Bedford, lat. 52° 8′ 28″ N., long. acc. 1^m W., at 10^h 45^m 53^s·2 M.T. observed the immersion of *i* Leonis, E. of the meridian: required the Longitude.

Gr. Date 10^h 47^m, Red. S.T. 19^h 6^m 8^s·5, star's R.A. 10^h 23^m 26^s·4, decl. 14° 58′ 38″·8 N., ☽ red. decl. 15° 49′ 40″ N., H P. 55′ 54″·9, Semid. 15′ 16″·1, geocen. lat. 51° 57′ 19″.

Arc A. 42′ 33″, B. 3′ 21″·5, C. 2″·3. Prep. decl. 15° 37′ 48″·0. Part I. 39^s·9, Pt. II. 2^m 12^s·6. ☽ R.A. 10^h 20^m 33^s·9. At 10^h, 10^h 18^m 55^s·5; at 11^h, 10^h 20^m 58^s·5. G.M.T. 10^h 48^m 0^s. By corr. of Part I. 10^h 47^m 45^s.

2. *Occultation of a Planet.*

875. *The Observation.* The planet having sensible semidiameter, the phenomenon does not take place instantaneously. Note the instant of final disappearance, or the instant of reappearance.

876. *The Computation.* Subtract the planet's horiz. parallax from the reduced horiz. parallax of the moon. Also subtract its semidiameter from the moon's semidiameter. In other respects proceed as for a star.

877. *Degree of Dependance.* A small error of Gr. Date will not sensibly affect the moon's parallax or semidiameter, and the declination is the only element liable to sensible error; Part I., therefore, is alone affected.

To find the error in the long. in time, caused by 1^m error of Gr. Date. Find the change of decl. in 1^m, add it to the diff. of declin., and recompute Part I.: the diff. between the result and Part I., as computed before, is the diff. or error of R.A. The error of long. *in time* will be, on the average, 30 times greater.*

If the star pass very near the moon's upper or lower limb, the observation is not good.

The inequality of the moon's surface, and an imperfect estimation of the figure of the earth, may cause small inaccuracies.

The cases least liable to error on the several accounts enumerated are those which occur when the moon is near the meridian, and in which the central zone of the moon passes over the star. The emersion from the dark limb is the case most distinctly marked.

No. 862 applies to this observation.

* Hence, to obtain the long. in time true to 1^s or 15″, the parallax in R.A. must be true to 0^s·003. This remark shews the difficulty of obtaining extreme precision from any single observation.

V. By Eclipses of Jupiter's Satellites.

878. The eclipse or disappearance of a satellite in the shadow of the planet, called the *Immersion*, or the reappearance after eclipse, called *Emersion*, being a phenomenon which takes place at the same absolute point of time wherever the spectator may be placed, affords a ready method of finding the longitude.

The diagrams of the positions of the planet and its satellites, as seen in N. lat., and other necessary information, are given in the Nautical Almanac. The figures must be reversed in S. lat. It will be convenient for the observer to bear in mind, that when Jupiter comes to the meridian before midnight, the whole eclipse (both immersion and emersion) takes place on the E. side of the planet; when after midnight, on the W. side. In an inverting telescope this will appear to be reversed.

879. *The Observation.* The telescope should have a magnifying power of not less than 40, and the observer should be ready some minutes before the time of observation, estimated by applying the long. by acc. to the time in the Nautical Almanac.

The sun should not be less than 8° below the horizon, nor Jupiter less than 8° above it, for the phenomenon to be distinctly visible.

880. *The Computation.* The difference between the M. T. at place, found by observation, and that at Greenwich, is the long.

Ex. Oct. 6th, 1822, near Igloolik, lat. 69° 21′ N., immersion of the 1st satellite, $10^h\ 29^m\ 33^s$, M. T. The M. T. at Gr., in the Nautical Almanac, is $15^h\ 56^m\ 0^s$; the diff., $5^h\ 26^m\ 27^s$, long. W.

881. *Degree of Dependance.* This method, though easy and convenient, is not very accurate; the eclipse is not instantaneous; and the clearness of the air, and the power employed, affect considerably the time of the phenomenon. Observers have been found to differ 40^s or 50^s in the same eclipse.

The observation may be considered complete only when the immersion and emersion of the same satellite are observed on the same evening, and as nearly as possible under the same circumstances. Thus, if the satellite disappear a little sooner than if the air had been clearer, it will emerge a little later from the same cause, and the mean of the two results may be near the truth.

The first satellite is preferable to the others on account of the greater rapidity of its motion.

CHAPTER VIII.

FINDING THE VARIATION OF THE COMPASS.

I. BY THE AMPLITUDE. II. BY THE AZIMUTH. III. BY ASTRONOMICAL BEARINGS. IV. BY TERRESTRIAL BEARINGS.

882. THE Variation is found by comparing the bearing of the sun or other celestial body, as shewn by the compass, with the true bearing as found by calculation. See No. 907.

883. When the time is known, the body may be observed, in the simplest cases, at its passage of the meridian, at which time it bears due N. or S., or at its passage of the prime vertical, when it bears due E. or W. In other cases, the true azimuth may be found by calculation.

When the time is not given the azimuth may be determined by observation of the altitude. When the altitude is nothing, or the body is on the horizon, as at rising or setting, it is usual to refer the bearing to the prime vertical, the angular distance from which (or the complement of the azimuth) is called the *amplitude*. The azimuth may also sometimes be determined from the observed difference of altitude in a measured interval of time.

The following rules are arranged more particularly for observations of the sun; but, after the explanations and precepts already given, no difficulty will occur in adapting them, when necessary, to observations of other celestial bodies.

I. BY THE AMPLITUDE.

884. This method, which is particularly convenient, is available twice a-day in fine weather, and at all seasons of the year.

885. *The Observation.** At sunrise, when the upper limb appears on the horizon, observe its bearing, and continue to take bearings of the centre, bisecting the sun's disc by keeping the up-

* The usual instructions for taking an amplitude direct the sun to be observed when his lower limb is half way between the centre and the horizon, at which time he is really on the horizon, No. 433. But as it is not easy to seize the bearing at the required instant, and still less so to observe several bearings equally distributed on both sides of the proper position, which is essential to a correct result, the sun is commonly observed a whole diameter too low. The observation as recommended above is more convenient in practice, and the error arising from not observing the sun at the instant to which the true amplitude corresponds (No. 446 (1)), is removed by the correction.

right wire on the upper limb, until the lower limb appears. Read off each bearing. At sunset, when the lower limb touches the horizon, proceed in like manner, until the upper limb disappears. See No. 221.

The mean of the readings, reckoning from the E. or W. point, is the *observed amplitude.*

886. *The Computation, by Inspection* (1.) Enter Table 59 with the Lat. and Declin., take out the amplitude, and mark it of the same name as the Declin.

(2.) Take from Table 59 A the correction. If this does not amount to nearly 1°, it may in general be omitted.

At *Rising.* In N. lat. apply the corr. to the *right* of the observed amplitude. In S. lat. apply it to the *left.*

At *Setting.* In N. lat. apply the corr. to the *left* of the observed amplitude. In S. lat. apply it to the *right.*

(3.) When the observed and true amplitudes are both N. or both S., their *difference* is the Variation. If one is N. and the other S., their *sum* is the Variation.

Then, the observer being in the centre of the compass, when the *observed* amplitude is to the *left* of the true, the Variation is East; when to the *right*, it is West.

Ex. 1. June 10th, lat. 17° N., long. 25° W., observed sun's amplitude at setting, W. 40° N.: required the Variation.

Lat. 17°, Decl. 23°, Amp. W. 24° N.
Obs. W. 40 N.
VAR. 16 W.

Ex. 2. June 10th, lat. 36° 40′ S., long. 17° W., obtained sun's amplitude at setting, W. 12°·3 N.: required the Variation.

Lat. 36°·7, Decl. 23°·0, Amp. W. 29°·2 N.
37° and 23°, Corr. 0°·7 } W. 13 ·0 N.
Obs. Amp. W. 12 ·3 N. }
VAR. 16 ·2 E.

Ex. 3. May 28th, lat. 47° N., long. 18° W., observed the sun's amplitude at rising, E. 10° N.

Lat. 47°, Decl. 21½°, Amp. E. 32°·5 N.
50° and 22°, Corr. 0°·9 } E. 9 ·1 N.
Obs. Amp. E. 10 ·0 N. }
VAR. 23 ·4 W.

Ex. 4. Sept. 25th, lat. 7° N., long. 151° E., observed the sun's amplitude at rising, E. 4° N.: required the Variation.

Lat. 7°, Decl. 1°, Amp. E. 1° S.
Obs. Amp. E. 4 N.
VAR. 5 E.

The Corr. here is 0.

The correction in Table 59 A is the same for a star or a planet as for the sun, and is applied in the same way. When the moon is employed, the correction, which, in the case of the sun or a star, involves the sum of the dip and horizontal refraction, is the excess of her horizontal parallax over this sum. As the moon's hor. par. is 1°. and the refraction ½°, in round numbers, this excess is about ½°, which is nearly the quantity employed in Table 59 A. This correction, therefore, serves for the moon, but it must be applied the *contrary* way to that directed for the sun.

887. *The Computation, Accurately.*

(1.) Find the Greenwich Date and reduce the declination to it.

(2.) To the log. sec. of the lat. add the log. sine of the declin.: the sum is the log. sine of the amplitude. Apply the correction as above.

888. *Degree of Dependance.* In low latitudes the amplitude is susceptible of much precision; in high latitudes refraction renders the result less certain. The relative temperature of the sea and the air produces no effect on the observed amplitude.

II. By the Azimuth.

1. *By Azimuth on the Meridian.*

890. *The Observation.* When the sun approaches the meridian observe the azimuth, and continue observing till the same time after noon. The mean of the readings is the observed azimuth.

When the sun is observed to the southward, if the observed bearing is to the E. of S., the variation is E.; if to the W., it is W. When he is observed to the North, the contrary in each case.

2. *By Azimuth from the Short Double Altitude.*

891. The true azimuth is obtained from the observation of the short double altitude, p. 256, without regard to the apparent time.

Case I. Observations on the *same* side of the meridian, No. 729.

892. *The Observation.* Observe the sun's azimuth during the interval between observing the alts., so as to obtain it at the middle of the interval. See No. 221.

893. *The Computation.* Having corrected the alts. and taken their difference, No. 729 (1), add together the log. sine of the diff. of alts., the log. cosec. of the interval,* and the log. sec. of the lat.: the sum is the log. sine of the azimuth at the middle time from noon, nearly.

Ex. (Ex. 1, p. 258.) Lat. 34° 40′ S., diff. of alts. 59′·1, interval $20^m\ 12^s$.

D. Alt.	0° 59′·1	sin.	8·2353
Int.	$20^m\ 12^s$	cosec.	1·0554
Lat.	34° 40′	sec.	0·0849
Azimuth	$13°\frac{3}{4}$	sin.	9·3756

This azimuth compared with that observed would afford the variation.

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* When it is intended to find the Variation by this method at the same time as the Latitude, it will be convenient to take the sum of these three logs. first. The five logs. employed in No. 729 will thus afford two distinct results.

894. *Degree of Dependance.* By adding to the result the diff. for 30″ in the sine of the D. alt., the effect on the azimuth of ½ in the diff. alts. is seen, and the effect of an error, or small variation of the D. alts. estimated. See also No. 679.

Case II. Observations on *different* sides of the meridian, No. 731.

895. *The Observation.* Observe the sun's azimuth when at the alt. nearest noon. See No. 221.

896. *The Computation.* Having found the time from noon of the greater alt., to the log. sine of this time add the log. cos. of the declin., and the log. sec. of the greater alt.; the sum is the log. sine of the azimuth at the time of observing the greater alt.

Ex. (Ex. 1, p. 259.) Time from noon, 11^m 59^s, decl. $5\frac{1}{2}°$, greater alt. 49° 41′.

T. from noon	11^m 59^s	sin. 8·718
Decl.	$5\frac{1}{2}°$	cos. 9·998
Great alt.	49° 41′	sec. 0·189
AZIMUTH	$4\frac{1}{2}°$	sin. 8·905

3. *By Azimuth from Equal Altitudes.*

897. The true azimuth may be obtained directly from the observation of equal altitudes at sea, for time, No. 798. The azimuth, being computed as directed in No. 801, and compared with that observed at one or both of the times of equal altitudes, determines the variation. The altitude is required with more precision than for finding the time by the method, No. 798.

This method is, however, not always eligible, because in low latitudes, where the observation of equal altitudes is favourable for the determination of time, the altitudes near noon are great, and therefore unfavourable for the observation of the azimuth. See No. 889.

4. *By Azimuth on the Prime Vertical.*

898. *The Observation.* Having found by Table 29 either the app. time or the altitude at the instant of the passage of the prime vertical, begin to observe a little before that time, and continue observing till the same time afterwards.

The mean of the readings, when it is not accurately E. or W., is the variation.

A.M. If the sun bear to the northward of E., the variation is E.; if to the southward, it is W.

P.M. If the sun bear to the northward of W., the variation is W.; if to the southward, it is E.

899. As a celestial body, when on the prime vertical, changes its azimuth more slowly than at any other time, an error in the apparent time will be of little consequence, and the method will be found one of the most convenient in practice in high latitudes during the six months that include the summer.

5. *By Azimuth deduced from an Altitude.*

900. *The Observation.* Take bearings of the sun's centre, noting the time of each reading. Take an alt. as soon as convenient before and after the bearings, noting the times.

901. *The Computation.* (1.) Having found the mean of the azimuths and of the corresponding times, reduce the alts. to the mean of the times, No. 660, reduce the decl., correct the alt., and find the azimuth, No. 673 or 674.

Ex. Feb. 19th, 1828, P.M., Paia Bay, Naples, lat. 40° 50′ N., long. 14° 3′ E., Mr. Fisher observed the mean of seven azimuths of the sun by Kater's compass, N. 223° 24′ E. (or S. 43° 24′ W.) Sun's true alt. 33° 34′; sun's reduced decl. 11° 14′ S.

By Expl. Tab. 5,			Dist. 100 and D. Lat. 88·5 give	
lat. 41°, alt. 33½° M 158·9	N	57·5	course or Az. S.	28° W.
Decl. 11¼°, dist. 159	Dep.	31·0 (lesser)	Ditto observed	43⅓
	Sum	88·5	VAR.	15⅓ W.

6. *By Azimuth deduced from the Time.*

902. The observation is already described in No. 900.

(1.) Find the Green. Date, to which reduce the declination and the elements employed in finding the hour-angle.

(2.) Compute the azimuth, No. 675.*

Ex. 1. June 23rd, 1829, P.M., at Constantinople, lat. 41° 1′ N., long. 28° 59′ E.; the mean of seven times by chron. $4^h\ 43^m\ 15^s$, and of seven azimuths of the sun, observed by Mr. Fisher with Kater's compass, between 286° 30′ and 288°, was N. 287° 16′ E., or N. 72° 44′ W.

Reduced pol. dist. 66° 33′.

Time	$4^h\ 43^m\ 15^s$				
Chron fast on A.T.	3 32				
Sun's Hour-angle	4 39 43	half $2^h\ 19^m\ 51^s$	cot. 0·15531		0·15531
Pol Dist.	66° 33′				
Colat.	48 59				
	114 92	half 57° 46′	sec. 0·27297	cosec.	0·07269
	17 34	8 47	cos. 9·99488	sin.	9·18383
		69° 19′	tan. 0·42316	14° 28′ tan.	9·41183
		14 28			
Azimuth		N 83 47 W.			
Do. observed		N 72 44 W.			
VAR.		11 3 W.			

Ex. 2. Dec. 27th, 1831, Lisbon, lat. 38° 42′ N., long. 9° 8′ W., Mr. Fisher observed the mean of ten azimuths of the sun by Kater's compass (between 165° and 166° 50′) to be N 166° 7′ E. The mean of the times by chron. (between $10^h\ 7^m\ 30^s$ and $10^h\ 15^m\ 45^s$) was $10^h\ 11^m\ 47^s$. Chron. fast on A.T. $42^m\ 18^s$; red. pol. dist. 113° 22′.

Computed Az. N. 143° 44′ E.; VAR. 22° 23′ W.

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* The work of finding the Azimuth is much lessened by the use of suitable tables. Burdwood and Davis's Azimuth tables and Star Azimuth tables extend from the equator to 60° latitude, and are published in a convenient form by J. D. Potter, 145 Minories, London, E. Such tables are indispensable for the navigation of iron ships. *See also* Lecky's "Wrinkles," for stars.

III. By Astronomical Bearings.

903. The true bearing of a point of land, or other terrestrial object, may be determined by means of the *difference of bearing* between it and the sun, or other celestial body; the true bearing of the latter being deduced by observation, or computed from the time.

The difference of bearing may be obtained directly by observing with the compass the bearings of both the sun and the object; or by the sextant, when the sun is on the horizon. But as the observation of two bearings at the same instant cannot always be conveniently made, the angular distance between the sun and the object is measured by a sextant or circle, and the bearing of the object alone observed. The difference of bearing is then deduced, by calculation, from the observed angular distance and the altitudes of the sun and the object.

The true azimuth of the object being thus obtained, the variation is deduced.

904. *The Observation.* Observe the sun's alt., then the angles between the object and the nearest and farthest limbs; lastly, observe the sun's alt., noting the times of each contact. Take the alt. of the object, at the point from which the sun's distance is measured.

When the variation is required at the same time, the bearing of the object must be obtained as nearly as possible at the time of the observation of the angular distance.

905. *The Computation.* (1.) Find the means of the times and angular distances, and reduce the sun's alt. to the mean of the times. Find the Green. Date, and reduce the sun's decl.; find his pol. dist., correct the obs. ang. dist., and the alt. of the object for index-error, when necessary.

Note. For common purposes, when the observer is not much elevated and the alt. of the object does not exceed a few minutes, the sun's decl. may be corrected at sight, the dip. refraction, parallax, and the alt. of the object neglected, and the precepts (2) and (4) omitted.

(2.) Find the app. alt. of the sun's centre (by applying the ind.-corr. dip, and semid.), and thence the true alt. by subtracting the refr. or corr. of alt.

(3.) Find the sun's true azimuth. When the sun is not near the meridian, this is found by No. 674. When he is near the meridian it is better found from the time, No. 675. The lat. will be required more correctly as the sun is nearer the meridian, and less so as he is farther from it.

(4.) For the corr. of ang. dist. arising from the point observed not being exactly on the true horizon. Take the diff. between the obs. alt. of the object and the apparent dip, Table 30.

To the log. sine of the remainder add the log. sine of the sun's app. alt. and the log. cosec. of the ang. dist.: the sum is the log. sine of the correction of the ang. dist.

When the dip is *less* than the alt. of the object, *add* the corr. to the ang. dist.; when the dip is the *greater* of the two, *subtract* it.

(5.) For the diff. of azimuth. To the log. cos. of the corrected ang. dist. add the log. sec. of the sun's app. alt.; the sum is the log. cos. of the diff. of azim. between the sun and the object.

When the ang. dist. exceeds 90°, take the supplement of the arc found as the diff. of azim.

(6.) For the Variation. Apply the diff. of azim. to the sun's azim., according to the case, which will be best understood by drawing a figure: the result is the true azim. or bearing of the object.

The true bearing compared with that observed shews the variation.

Ex. Dec. 4th, 1819, at $7^h\,30^m$ A.M., in Pernambuco Road, lat. 8° 4′ S., long. 34° 52′ W., M. Givry took the following alts. and angular dist., height of the eye 16 feet, ind.-corr. 0 — (*Mem. sur l'Emploi, &c.*)

Time by W.	$7^h\,25^m\,40^s$	Alt. ⊙	23° 16ᵐ	Ang. Dist. Circle. 190° 30′ 30″	Object. S. 31° 40′ W.
	7 26 10		23 23		Alt. 0 10
Mean			23 19 5	95 15 15	Corr. 0.

(1.)

Green. Date, 3d, $21^h\,47^m$	Red. Decl.	22° 10′ 47″ S.
	Pol. Dist.	67 49

(2.)

Obs. Alt.		23° 19′ 8
−4′ } +16 2 }		+ 12 2
App. Alt.		23 32 0
		− 2
True Alt.		23 30

(3.) Sun's Azimuth.

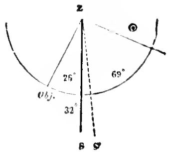
Pol. Dist.	67° 49′		
Lat.	8 4	sec.	0·00432
Alt.	23 30	sec.	0·03760
	99 23		
	49 41	cos.	9·81091
	18 8	cos.	9·97788
	110 45	sin. sq.	9·83071
	or S. 69 15 E.		

(4.) Corr. of Ang. Dist.

(Alt.) 10′ − (dip) 4′ = 6		sine	7·242
⊙ Alt.	23° 30′	sine	9·601
Dist.	95 15	cosec.	0·002
	+ 2	sine	6·845
Corr. Ang. Dist.	95 17		

(5 & 6.) Computation of Diff. of Azim.

Ang. Dist.	95° 17′	cos. 8·9642
⊙ Alt.	23 30	sec. 0·0376
Suppl.	84° 14	cos. 9·0018
	95 46	
⊙ Az.	S 69 15 E.	
Obj. Az.	S 26 31 W.	
Observed	S 31 40 W.	
Var.	5 11 W.	



IV. By Terrestrial Bearings.

906. The true bearing or azimuth of a mountain, at a considerable distance, is determined from its geographical position and that of the observer. As the true azimuth and the course on the great circle are the same thing, the problem is that in No. 339 (1), p. 133. But as mountains are rarely seen much beyond a hundred miles, it is near enough to proceed thus:—

Find the D. Lat. and D. Long. between the places in minutes of arc. Turn the D. Long. into Dep., No. 318 or 319. Find the Course, No. 280 (1). This is the approximate azimuth.

With the mid. lat. as a course, and the D. Long. as dist., find the Dep.; this is a number of minutes, one-half of which is to be subtracted from the approx. azim.; the remainder is the true azimuth, very nearly.

Ex. Lat. 60° 6′ N., long. 142° 50′ W., find the true azim. of Mt. St. Elias in lat. 60° 18′, long. 140° 52′.

D. Lat. 12 and D. Long. 118 give Dep. 58·6, and Course 78° 26′. Then 60° and 118 give Dep. 102 2; and 51′ subtracted from 78° 26′ gives the Azim. N. 77° 35′ E.

In low latitudes, and in all cases when the object is near N. or S., the correction may be neglected. (For more precision, see No. 395, p. 151.)

907. The term Variation, as defined in No. 882, and used in this chapter, is the difference between the true bearing of any object and its bearing by a compass. From what has been said in Chapter II., this quantity must differ from the correct variation by the instrumental error of the compass, by the local effects of the land, and, further, on board ship, by the deviation.

There may be instrumental errors in a compass, which cannot be detected unless the correct magnetic bearing of some object is known. For this reason it is desirable, when there is any reason to suspect the accuracy of the standard compass, that advantage should be taken of being in a port where the exact variation is known, to examine the compass according to the process described in No. 224. Errors in observed bearing, arising from the sight-vane not being vertical, or from the reflector being out of place, may be avoided by using low azimuth's amplitudes, or nearly horizontal bearings of terrestrial objects. Errors arising from the centre of the card not being in the same vertical plane as the line of sight, may be avoided by taking bearings of several objects distributed round the horizon. The true bearing of one object may be determined by process III. or IV., the others by horizontal angles therefrom.

The effects of such local disturbances as are mentioned in No. 222 may generally be eliminated, either on land or at sea, by observing in several positions, with the view of getting on opposite sides of the disturbing cause, and taking the mean of the results as the correct variation.

When an observation is made at sea with a compass which is instrumentally correct, and is free from local disturbance of the land or ground, the difference between a true bearing and a compass bearing, commonly called the *Total Error*, enables the navigator to shape a correct true course. This is in general all that is actually required for navigation. But such an observation would not determine the variation, unless the deviation is exactly known. A good value of the deviation may be obtained by interpolation, if the ship has been swung a short time previously, and again a short time after. Allowing the same on the total error will give the variation.

When the compass is well placed, the mean of the total errors on two opposite cardinal points is a good value of the variation. A still better value may be obtained by taking the mean of the total errors on the four cardinal points.

To obtain an accurate compass bearing, it is necessary that the ship's head should be steadied as directed in No. 248. When a ship's head is moving to port or starboard, the compass card is obviously liable to be dragged round in the same direction as the head is moving, by the friction on the pivot. On the other hand, in iron ships it has been found, that when the head is moving to the right, the compass-needle stands a little to the left of its due position, and *vice versá*. The last mentioned effect of the ship's motion in azimuth is especially noticeable when the ship's head is near the north or south points. It is due, possibly, to the transient magnetism not instantly adapting itself to the position of the ship, as she moves round in azimuth. An exact bearing can be obtained by taking the mean of two, taken with the ship's head moving in opposite directions; also an accurate deviation-table may be quickly obtained by turning a ship round to port and to starboard under steam, making use of the sun's azimuth, and taking the mean on the four cardinal points as the variation, where it is not otherwise known.

Reduction of the True Course to the Course by Compass.

908. When the true course to be steered is determined, it must be reduced to the course by compass. The variation of the compass is to be applied (No. 221); the result is the *correct magnetic course.* See p. 159.

When the total error (No. 907) of the compass is known, it is to be applied to the true course, otherwise the deviation (No. 227) must be applied to the *correct magnetic course*; the result is the *course by compass.*

CHAPTER IX.

THE TIDES.

I. PHENOMENA OF THE TIDES. II. RULES FOR FINDING THE TIME OF HIGH WATER. III. TIDE-OBSERVATIONS.

IN this chapter we shall attempt merely a general enumeration of the principal phenomena of the tides, with such other matters as are of direct practical importance.*

I. PHENOMENA OF THE TIDES.

909. The connexion observed in all ages, and, with particular exceptions, in all places, between the succession of high waters and the moon's meridian passage, has established the belief that the moon is the cause of the tides. The principle of gravitation,† on which the motions of the earth and the celestial bodies are calculated, and their figures explained, has confirmed, and at the same time corrected, this belief, by shewing that sensible effects must be produced not only by the moon, but also by the sun, though, from her greater nearness, the moon has by far the greater influence; and the general result would, naturally, until the observations were analysed, be attributed exclusively to her.

910. The attraction of the moon acting most strongly on those parts of the ocean which are nearest to her, that is, over which she is vertical, tends to draw these parts towards her, while their place is supplied by the water at the sides of the globe. And since the central parts are likewise more affected in the same action than the surface at the opposite or farthest side, the figure of the earth becomes elongated in the direction of a line drawn towards the moon; that is, the water is accumulated at the point exactly under

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* The reader may refer, for additional information, to various papers, by Sir John Lubbock and the Rev. Dr. Whewell, in the *Philosophical Transactions*, &c., 1833, particularly to "An Essay towards a Map of Cotidal Lines," followed by other dissertations by Dr Whewell; and to "The Tides," by Professor George Howard Darwin (John Murray, Albemarle Street).

† This principle is that there subsists amongst all particles of matter a mutual attraction whose intensity is inversely as the square of the distance.

the moon, and at another point distant from the former 180° in latitude and longitude. The moon, in her progress to the westward, causes thus, at each meridian in succession, a high water, not by drawing after her the water first raised, but by raising continually that under her at the time.

The opposite high water, or, as it is called, the *inferior* tide, would, if the moon's action was uninterrupted, follow the other, or *superior* tide, after the interval of half a lunar day, or $12^h\ 24^m$ on the average.

Again, the sun, acting in the same manner, though with less force than the moon (in consequence of his distance more than counterbalancing his greater magnitude), produces two tides, which would follow each other, if uninterrupted, after an interval of half a solar day, or 12 hours.

911. But, instead of four separate tides produced by the independent actions of both bodies on the mass of waters in their original form, the effect produced is the same as if, after one of the bodies, as the moon for example, has given a form to the waters, the sun alters that form, the two separate actions thus producing a joint result. Hence the place at which it is high water is that at which the *sum* of the heights of the tides produced by the two bodies is greater than any where else.

912. When the sun and moon are on the meridian together, their actions concur, and the tide is higher than at any other time. The same holds when they are in opposition. These highest tides are called *spring-tides*, and occur after new and full moon. Again, when the sun and moon are 90° apart, their actions tend to neutralise each other; and the *neap-tides*, which occur after the first and third quarters of the moon, are the smallest of all. (See No. 919.)

913. Since the sun and moon act with greater force as they are nearer, the effect of each body in raising the tide is greater as its parallax is greater (No. 436). The highest spring-tides would occur, therefore, in January, about the time of the month when the moon's hor. par. is greatest. But the effect of both bodies is greater, generally speaking, as their alts. are greater, since when vertical the effect is greatest. This period, therefore, depends on circumstances.

914. If the actions of the sun and moon were, as we have hitherto supposed, uninterrupted by obstacles or forces of any other kinds, the tides would be regular, and their calculation certain. But from the unequal depth of the ocean, and the barriers presented by continents which stand across the natural progress of the tides, their motion is interrupted, and the *tide-wave* (as the accumulation of waters is called), abandoned by the forces which originated it, becomes subjected to the mechanical action proper to waves in general.

915. It is necessary to distinguish between the motion of a wave and that of a current. A wave is not an absolute transfer of the body of moving water in the direction of the motion of the waves, but is a motion perpendicular to the surface, or up and down. The

motion of waves is represented in the fluttering of a flag and the shaking of a sail. It is easy to see that this kind of motion is compatible with immense velocity, without any appreciable current in the water itself; thus the tide-wave appears to pass from the Cape of Good Hope to Cape Blanco in twelve hours.

916. The motion of waves is quicker as the water is deeper. Also, the largest waves are the swiftest; a fact illustrated by the superior velocity of a heavy sea over that of the rippling of a pool. When the water shoals, the wave is retarded and becomes steeper on the advancing side, as is seen in the approach of waves to a shelving shore, and in the bores of rivers. The velocity of waves is also considered to be greater as their length (or distance from hollow to hollow) is greater; thus the tide-wave, though inferior in height to the waves of an agitated sea, yet travels with prodigiously greater velocity. Waves of different size and velocity merge into one another, as is known to those who have endeavoured to follow with the eye the waves of the sea. Lastly, when the waves meet with obstacles, such as sand-banks or reefs, the directions of their motions, as well as their figures, are changed. Several of the anomalies which the tides present are attributed to these and like circumstances.*

917. The current which accompanies the tide, and changes its direction with the ebb and flow, is the effect of the alteration of the level of the water during the passage of the tide-wave. Also, when a body of water in a channel has been set in motion, the motion does not immediately cease with the cause that produced it. Hence the *tide-current* does not necessarily, and in all cases, change with the tide; and thus, under certain circumstances, the current of the ebb continues to run for some hours after the flood-tide has made.

It is considered probable that many of the anomalies in recorded times of tide have arisen from thus confounding the time of high or low water with the time of slack water.

Admiral Beechey, who bestowed much attention upon the complicated movements of the tides on our Western coasts, states that though each point of the coast in the Irish Channel has its proper time of high water, yet the turn of the stream takes place simultaneously to all, namely, about the time of high water at Morecombe Bay. This time is nearly that of Liverpool; accordingly, in order to know whether the stream is setting into the Irish Channel or out of it, it is necessary merely to find whether the tide is rising or falling at this place. Thus while the tide-wave, in coming in, is making it high water at the different places succeeding each other in its progress, the *stream* is, nevertheless, running out.†

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* Among the most curious of these effects are those called *interferences*, whereby two distinct sets of waves may, in their combination, produce apparent rest. See *Phil. Trans.* 1832, p. 154. On this principle are explained, also, tides which occur at irregular intervals.

† A Report of Observations made on the Tides in the Irish Sea, &c., by Capt. F. W. Beechey, R.N., *Phil. Trans.* 1848; see also *Naut. Mag.* 1849, p. 70.

918. The *height* of the tide is the difference between the level of high water and that of low water.*

The height of the tide in the open ocean is supposed to be very small; and the great heights observed on some shores are evidently due to the shoaling of the water and the narrowing of the channel.

The tides are insensible or very small in inland seas; as also in high latitudes, except from local causes.†

919. It is found, in general, that the tide is not due to the moon's transit immediately preceding, but to a transit which has occurred some time before. The time thus elapsed between the transit at which the tide originated and the appearance of the tide itself is called the *retard*, or *age of the tide*.

Thus the tide on the western coasts of Spain and France is a day and a half old; that at London is two days and a half old.

It appears certain that the age of the tide on the W. coast of Ireland is 2 days (p. 38), and on the S. W. coast $1^d\ 20^h$ (p. 110).‡

It would appear further that changes in the parallax and declinations of the sun and moon produce their several effects on the time and height of the tide after particular intervals.

It is thus constantly necessary to discriminate between a tide which may happen after any particular transit and the tide which really *corresponds* to that transit; thus, for example, if the moon passes the meridian at 4 P.M. to-day, and the high water occurs at 7 P.M., this tide will not in general be that which *corresponds* to the transit 3 hours before, but may have had its origin several transits back. The transit to which the tide really corresponds is found by examining the observations of the several preceding tides, the highest of which, being due to the united actions of the sun and moon, is known to correspond to the moon's transit at 12 o'clock, noon or midnight.

920. The *mean level* of the sea is the middle between the levels of high water and low water.

Though the heights of high water and those of low water may vary considerably, yet the mean level seems confined to very narrow limits. Thus, at Singapore, where the heights of two consecutive low waters differ sometimes six feet, the mean level varies only a few inches.—*Phil. Trans.* 1837.

Hence it follows that heights measured above the sea should be referred to the mean level as the standard or zero, instead of that of either low or high water.

It is not, however, to be supposed that the middle point between any two consecutive tides is the mean level. This will be the case

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* The term *range* would be preferable to *height*, as it implies a distance between boundaries, as, for ex., the range of the barometer. The "height of the tide" is continually, in common discourse, used for the height of the water.

† Sir John Ross found a rise and fall of 8 feet in lat. 74° N.

‡ On the Law of the Tides of the Coasts of Ireland, by G. B. Airy, Esq., Astronomer Royal, *Phil. Trans.* 1845. This paper refers to a most extensive and complete series of observations made in 1812 under Gen. Colby, director of the Trigonometrical Survey chiefly for the purpose of referring the elevations observed to the level of the sea.

only when two tides in succession attain the same high-water level and the same low-water level, as at springs.

921. By the *Establishment of the Port* or *Tide-hour* has been commonly understood the apparent time of the first high water that takes place in the afternoon of the day of full or change. This Dr. Whewell has called the Vulgar Establishment.

922. The interval between the moon's transit and the high water next following is called a *lunitidal interval*.

The lunitidal interval varies from day to day during the fortnight between full and change.

923. The *correct establishment* is the lunitidal interval corresponding to the day on which the moon passes the meridian exactly at noon (with the sun) or at midnight. This is found by taking the mean of all the times of H. W. for a fortnight. The Vulgar Estab. may thus be an hour, or considerably more, in error when used as representing the H. W. on *any* day of the fortnight.

The tide caused by the united actions of the sun and moon, when each of these bodies is in one of the positions most favourable for raising the water, is identified by its superior height. And it is thus found (as observed in No. 919) that the interval by which the tide follows the moon on the day when the full or change occurs at 12 o'clock, or the lunitidal interval *corresponding* to that particular transit, is not the interval actually observed *on* that day.

The establishment of the port, and also the height of the tide, appear to be subject to change.

924. The difference between the lunitidal interval at each transit of the moon and the correct establishment is called (by Sir J. Lubbock), from the period of its recurrence, the *semi-menstrual inequality*.

This inequality is found to be different for different places; hence the time of high water at any place cannot, generally, be accurately deduced from that at any other place by merely applying the difference of time between the two establishments.

925. The tide is subject, in like manner, to a semi-menstrual inequality in the height. This inequality being, like that in the time, different for different places, the height of a tide at any one place cannot always be correctly inferred from the given height at any other.

926. It has been found that the morning and afternoon tides do not rise to the same height; the difference is called the *Diurnal Inequality*.

This irregularity is the consequence of the sun and moon not being always on the equator. Thus, suppose the moon in 20° N. declin.: then the summit of the superior tide is in 20° N. lat., and of the inferior tide in 20° S. lat., each alternate tide having thus its greatest elevation in the other hemisphere. The diurnal inequality is subject to steady rules, and may be predicted.

927. The maximum of the diurnal inequality *corresponds* to the moon's greatest declination, though it may not appear till after the

time of the greatest declination. In like manner, it disappears with the moon's declination, but not till some time after she has crossed the equator. For example, the age, as it may be termed, of this inequality is, at Liverpool, six days; at Singapore, a day and a half. A diurnal inequality appears in the times, as well as in the heights, of the morning and afternoon tides.

928. The *Diurnal Inequality* is a feature in tidal phenomena, which, being particularly small in British waters, has not received the attention it merits from the English sailor, for in the Indian seas,* and indeed in most other parts of the globe, this diurnal inequality is a regular change, considerable in amount, and almost universal in prevalence.

In consequence of the diurnal inequality, it sometimes happens that the day tides are higher than the night tides, or the reverse, for many weeks together. And hence it has sometimes been stated at such places, that the day tides are always the highest, or the reverse. But this is not the case. The rule of the diurnal inequality depending on the declination of the moon and sun, if the day tides are the highest at one time of the year, they are the lowest at another.

The diurnal inequality sometimes affects the time of high water as much as two hours, that of low water about forty minutes; at the same time a variation of twelve inches may be observed in the height of high water, and of thirty-six inches in that of low water. Such effects are far too great to be neglected, either in the prediction of tides or the reduction of soundings.

929. Strong winds affect the time and height of the tide, but chiefly the former, especially in rivers and narrow seas.†

The pressure of the atmosphere also affects the height of the tide, the water being in general higher as the barometer is lower.‡

930. Though high and low water may succeed each other regularly as to time, yet the water does not always rise and fall at the same rate. Thus, for ex., the water in some places falls faster during the first of the tide than afterwards.

Irregularities both in the duration of the tide and in the rate at which the water rises or falls, are, however, most conspicuous in rivers.§ At Limerick and New Ross, the fall of the water occupies a longer time than the rise; at most other stations the rise appears to occupy a little longer time than the fall. This last, however, appears less certain.—*Phil. Trans.*, 1845, "Law of Tides."

* See Tide Tables for the Indian Ports, by Captain S. G. Burrard, R.E., and Mr. E. Roberts, F.R.A.S., F.S.S., published yearly by the authority of the Secretary of State for India.

† Adm. Beechey acquainted me that he considered strong winds do not raise the water more than 2 feet, even in the Bristol Channel, where the range is above 40 feet.

‡ It has been established that a rise in the barometer of an inch is accompanied by a fall in the height of the water of 12 or 14 inches. This opposite motion of the water and the mercury due to the atmospheric pressure was established by Mr. Daussy in discussing the tide-observations made at Brest.

§ At Limerick, after low water, the water sometimes rises as much in ten minutes as it had previously dropped in two hours. Such irregularities cause considerable difficulty in ascertaining the true state of the case.

II. Rules for Finding the Time of High Water.

931. The first of the two following rules, which is the old method of finding the time of high water by the moon's age, affords merely a rough estimate, as it may be in error nearly two hours. The second, which involves the semi-menstrual inequality, will be found a tolerable approximation on our own coasts, being generally within 15^m or 20^m; but as each place has a different semi-menstrual inequality, the degree of accuracy which it may possess as applied to other parts of the world than those for which the table is constructed, cannot be pronounced.

Complete rules for computing the time and the height of the tide involve, also, corrections for parallax and declination, and require special tables for each port.*

932. Rule I. for a *rough estimate.* (1.) For the moon's age. To the epact of the year, Table 14, add the epact of the month, and the day of the month. The result, if less than $29^d\ 13^h$, is the moon's age at noon; if it exceed $29^d\ 13^h$, subtract $29^d\ 13^h$.

In leap-years, in January and February, deduct 1 day.

(2.) For the moon's meridian passage.† Multiply her age, to the nearest day, by 8, and point off one decimal: the result is the time of the merid. passage nearly.‡

(3.) For the time of high water. To the time of merid. pass. add the establishment of the port (or tide-hour).

(4.) If the sum be less than 12 hours, it is the time of high water P.M.; if it exceed 12 hours, it is the time of high water next morning; and, to obtain the time for P.M. on the present day, subtract $12^h\ 24^m$.

If the sum exceed 24 hours, it is the apparent time of high water P.M. the next day; for the time P.M. on the proposed day, subtract $24^h\ 48^m$.

Note.—This rule supposes that the tide always follows the moon by the same interval; but this interval, generally speaking, is different for each day of the fortnight. See No. 923.

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* Such tables are given in the Tides published annually by the Hydrographic Office. The errors of the predicted times do not appear to exceed five or ten minutes, except in gales of wind, when the time of high water may be altered upwards of half an hour.

† This is often called *southing;* but as in south latitude the moon passes the meridian to the northward, this term is not adapted to general use.

‡ The moon's age thus found may be more than a day in error, but her merid. pass. will generally be less than an hour in error.

Ex. 1. Find the time of high water at Falmouth, Oct. 3d, 1891.

Epact 1891	20^d	9^h
Do. Oct.	7	5
Days	3	
	30	14
	−29	13
	1	
	8	
☽'s Mer. Pass.	$0{\cdot}8 = 0^h$	48^m
Tide hour	+4	57
Time of H.W.	5	45 P.M.

Ex. 2. Required the time of high water at Shields, March 31st, 1891.

Epact 1891	20^d	9^h
Do. March	29	11
Days	31	
	80	20
	−59	2
	21	18
	8	
	$16{\cdot}8 = 16^h$	48^m
Tide-hour	+3	21
	20	09
	12	24
Time of H.W.	7	45 P.M.

Ex. 3. Find the time of high water at Liverpool, March 10th, 1891.
Tide hour $11^h\ 23^m$ Time of H.W. $11^h\ 23^m$ P.M.

Ex. 4. March 30th, 1891, find the time of high water at Portsmouth.
Tide-hour $11^h\ 41^m$ Time of H.W. $2^h\ 53^m$ P.M.

Ex. 5. June 2d, 1891, find the time of high water at Liverpool.
Tide-hour $11^h\ 23^m$ Time of H.W. $7^h\ 15^m$ P.M.

933. Rule II. (1.) Take from the Nautical Almanac the M.T. of the moon's meridian passage, and correct it for the longitude by Table 28.

(2.) Take from Table 15 the semi-menstrual inequality corresponding to this time, and apply it to the reduced time of mer. pass. as directed in the table. To this result add the tide-hour, and the sum is the time of high water.

(3.) When this time exceeds 12 hours, it is the time of high water past midnight,—that is, A.M. the next day.

When, therefore, the P.M. tide preceding is required, it is necessary to employ the *inferior* transit of the moon.

Ex. 1. Aug. 6 h, 1891, find the time of high water at Shields. Long. 1° 25′ W.; tide-hour $3^h\ 21^m$.

☽'s tr. 6th	1^h	33^m
Corr. for long.	0	0
Sem. ineq.	−0	21
	1	12
Tide-hour	3	21
Time of H.W. 6th	4	33 P.M.

Inf. tr. 6th	1^h	5^m A.M.
Sem. ineq.	−	14
		51
Tide-hour	3	21
Time of H.W.	4	12 A.M.

Ex. 2. Aug. 29th, 1891, find the time of H.W at Portsmouth.
Tide-hour $11^h\ 41^m$. High Water 29th, $7^h\ 10^m$ A.M. and $7^h\ 54^m$ P.M. on 29th.

Ex. 3. March 11th, 1891, find the time of high water at Cherbourg.
Tide-hour $8^h\ 0^m$. High Water 11th, $8^h\ 32^m$ A.M., $8^h\ 53^m$ P.M.

(4.) When the time of the moon's transit on the given day exceeds 12 hours, the transit occurs A.M. on the *next* day (civil time). It is evident, therefore, that to obtain the times of high water on the same day, we must, in such cases, employ the transit of the preceding day.

Subtract 12^h from the time of transit, to enter the table of the semi-menstrual inequality.

To find the other tide, we must employ the inferior transit as already directed.

Ex. 4. April 8th, 1891, find the times of high water at Shields.

☽'s tr. April 7th	$23^h\ 49^m$	For the A.M. tide preceding.	
Corr. for long.	0	Inferior trans. April 7th	$11^h\ 21^m$
Sem. ineq.	+ 2	Sem ineq.	+ 8
Tide-hour	+ 3 21	Tide-hour	+ 3 21
TIME OF H.W. April 7th	27 12 P.M.	TIME OF H.W. April 7th	14 50 P.M.
or April 8th	3 12 P.M.	or April 8th	2 50 A.M.

Ex. 5. July 20th, 1891, find the times of high water at Tynemouth bar. Tide-hour $3^h\ 20^m$. HIGH WATER July 20th, $2^h\ 4^m$ A.M., and $2^h\ 28^m$ P.M.

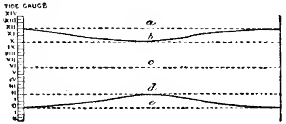
934. When the range of tide is considerable, and the depth not great, and it is required to identify the place of the ship by the soundings, or when about to enter a harbour in a vessel whose draught of water is nearly equal to the depth, it is necessary to find the height of the tide as exactly as circumstances permit. If the place is one of those of which particulars are given in the tide-tables published by the Hydrographic Office, the depth is found by the rules there given.* When such tables are not at hand, it may be found approximately by Table 16.

935. It is proper to remark that the age of the tide is necessary to the computation of its height. Thus, suppose it is H.W. at $2^h\ 30^m$ P.M. on Monday, the day of change. Now, if this H.W. is the tide *really corresponding* to the transit of the sun and moon together (No. 919), it will also be that which gives the spring range; the next range, therefore, will be less, and each range in succession will go on decreasing to the neap-tide. But if the age of the tide, in the supposed case, is 2 days, that is, if the highest tide does not follow till 2 days later, or till Wednesday afternoon, then the range on Monday will not be so high as on Wednesday; that is, the range, instead of *decreasing* continually to the neap-tide, will go on *increasing* for the next 2 days; after which it will begin to decrease until the neap-tide, which will take place 2 days after the 1st quarter, and not on the day of the 1st quarter.

* The soundings marked on the Admiralty Charts show the depth at Low Water ordinary springs; hence a correction has to be applied to the soundings obtained to compare it with these shown upon the chart to know the depth over a bar or in a harbour. *See* Table on p. 344.

TIDES.

The following Diagram is intended to explain the terms Spring Rise, Neap Rise, and Neap Range, as made use of in this work.



a = Mean level of High Water Ordinary Springs.
b = ,, ,, ,, Neaps.
c = Half Tide or Mean Level of the sea both at Springs and Neaps.
d = Mean Level of Low Water Ordinary Neaps.
e = ,, ,, ,, Springs.

Example.

Spring Rise (or Mean Spring Range) = e to a = 12 ft.
Neap Rise . . . . . = e to b = 10 ft.
Neap Range . . . . = d to b = 8 ft.

For ordinary purposes the following Table, for Reducing Soundings to the Mean Low Water Spring Tides, will be found sufficiently correct, except where the Tides are affected by a large diurnal inequality.

At Spring Tides.

At the 1st hour, before and after high water, deduct	$\frac{11}{12}$	Of the rise at springs.
,, 2nd ,, ,, ,, ,, ,,	$\frac{3}{4}$	
,, 3rd ,, ,, ,, ,, ,,	$\frac{1}{2}$	
,, 4th ,, ,, ,, ,, ,,	$\frac{1}{3}$	
,, 5th ,, ,, ,, ,, ,,	$\frac{1}{8}$	
,, 6th ,, ,, ,, ,, ,,	0	

At Neaps.

At the 1st hour, before and after high water, deduct	$\frac{4}{5}$	Of the rise at springs
,, 2nd ,, ,, ,, ,, ,,	$\frac{3}{4}$	
,, 3rd ,, ,, ,, ,, ,,	$\frac{1}{2}$	
,, 4th ,, ,, ,, ,, ,,	$\frac{1}{4}$	
,, 5th ,, ,, ,, ,, ,,	$\frac{1}{5}$	
,, 6th ,, ,, ,, ,, ,,	$\frac{1}{6}$	

Trinity High-Water Mark, as established by Act of Parliament in 1800, is cut upon a large stone on the lower outer wing wall of the Hermitage entrance of the London Docks. Trinity high-water mark is 12·53 feet above the Datum used by the Ordnance Survey, *i.e.* Mean Level of the sea at Liverpool; therefore by obtaining from the Ordnance map the level of any Bench mark and applying 12·53 feet to it, the level of the Trinity high-water mark is found.

The Trinity high-water mark will be found cut upon the Tower Wharf, and also upon the front of the Fishmongers' Hall Wharf, next above London Bridge.

III. Tide-Observations.

936. It is evident, from what has been said (Nos. 919, 922), that the establishment cannot be truly deduced from the notice of a solitary high water; and that observations, continued, at least through a semi-lunation, are necessary for even a tolerable approximation. But the true establishment cannot be successfully determined from a series of observations involving the semi-menstrual inequality, the various effects of changing declinations and parallaxes, with temporary and local circumstances, except by persons not only thoroughly versed in arithmetical operations on an extensive scale, but well exercised in the particular intricacies of these laborious calculations. We have, therefore, confined ourselves here to merely indicating the details which should accompany tide-observations.

(1.) The exact *spot of observation* must be specified.

(2.) The *instant* of both *high water* and *low water* should be stated, with the *height*, or difference of the two levels, in feet and inches. As the water hangs for some time towards the turn of the tide, and as the tide-current may be independent, it is necessary to note the instant at which the water passes a fixed mark, both in rising and falling; the means of these times are the instants of high and low water respectively. The marks should be fixed in some place to which the water passes slowly, because the waves, however small, continually washing over the marks, render it difficult to detect a small rise or fall of the water.

The observations of both low and high waters of the 24^h are necessary for determining the Diurnal Inequality; but as the time of this inequality is of less importance than the height, it will often be enough, in respect to this particular point, to note the height alone.

About mean water (or half tide) the surface rises or falls with greater velocity than at any other time, and accordingly the instant at which the water passes a fixed mark or a given horizontal line may be observed with greater precision than at any other time. Hence it has been recommended to notice the instant of passing one or two such marks, instead of the times of high and low water.—"On the Law of the Rise and Fall of the Sea's Surface during each Tide."—*Phil. Trans.*, Part II. for 1840.

It has been proposed to place the marks at half-tide, but this does not answer, especially where the diurnal inequality is considerable.* The intervals should be short on either side, of high and low water because the tides do not rise and fall with equal velocity.

(3.) The times of *slack water* should be noted.

(4.) The direction, and, in general terms, the force of the *wind*, should be stated, as, also, the height of the barometer.

As the effects of winds and atmospherical changes are not confined to the particular hours during which such causes are in action, it will be proper, when only a short series of observations can be obtained, to add further a brief notice of the state of the weather for some time previous.

Observations continued for a fortnight afford a first approximation to the Tide-hour; and when carried on for some months, this, with some other principal elements, may be obtained with considerable accuracy.

937. The custom has prevailed of noting the establishment as the *hour of the day;* but it obviously should, as recommended by Dr. Whewell (*Phil. Trans.* 1833, p. 229), be considered merely as an *interval.* Since the correct establishment is measured from twelve o'clock, it may, indeed, appear to be indifferent whether we call it an absolute time or an interval; but the *absolute time* of the tide is in all cases referred to the instant of the moon's transit, and it is absurd to talk of adding two absolute times together; as, for example, adding three o'clock of the day to five o'clock of the day. Also, by considering the establishment as an interval only, we avoid confounding mean and apparent times.

938. The soundings on the charts are the depths at "low water;" but this term may imply indifferently the mean low water of the whole year, or of the equinoctial spring-tides, of which the average is not always identical, or of those low waters only which were observed during the operations of survey. Since these may differ considerably from each other, the computed depth may be in error by the same difference. It might appear less equivocal if the lowest of all the low waters were understood; but this, though a natural phenomenon, and, so far, preferable to an imaginary standard, as an average, is still defective, since it is affected by winds. It would appear, therefore, as Capt. Beechey proposes,† that the standard low water should be identified as so many feet and inches below the mean level, which appears to be the only element nearly constant.

The mean level may, it appears, be found approximately by observations of four consecutive tides, which include the diurnal inequality.

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* Adm. Bayfield (to whom I am indebted for some important remarks and corrections here and elsewhere in the former editions) informs me that in the St. Lawrence the alternate ebbs do not fall to the half-tide mark at all when the diurnal inequality is considerable. Also Adm. Beechey acquainted me, as the result of numerous observations, that at Plymouth the half-interval of time between the passages over the half-tide marks requires $\frac{1}{30}$ of the whole int. to be added to it for the correct time of high water, in consequence of the unequal rise and fall.

† "A Report of Observations," &c

NAVIGATING THE SHIP

I. Shaping the Course. II. Place of the Ship. III. Determining the Current. IV. Storms. V. Making the Land.

939. In the preceding part of this volume each point of the subject has been treated separately. The present section, which will conclude the Practice, and to which the former chapters may be considered subservient, contains matters of general reference in conducting the navigation of the ship.

I. Shaping the Course.

940. As soon as the ship is clear of the land, and circumstances permit, her head is put upon the course to be steered, the log hove, and the departure taken.

When the course is to be shaped for a distant port, recourse is had, in defect of personal experience, to the Sailing Directions,* in order to learn what point to steer for, so as to profit by particular winds or currents, or to avoid dangers. The bearing of such point is then worked for by parallel, middle latitude, or Mercator's sailing, according to the case; or, a ruler being laid on the chart over the place of departure, and the point in question shews the course, No. 381.

941. When the wind is foul, reference will be made to No. 299; but, in the case of a prevailing foul wind, the proper line of proceeding will be indicated in the Sailing Directions.

A steam-vessel will generally preserve her course without regard to the wind, except in long passages.

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* The Sailing Directions contain descriptions of ports and anchorages, with accounts of the winds, currents, and tides, for various coasts and seas. Besides these and other particulars, necessary for navigation alone, works of this kind contain well-selected passages from voyages and travels, by which the reader may obtain clear ideas of the physical aspect of the shores, climate, and natural phenomena of most parts of the world, and derive considerable information respecting the manners and customs of the inhabitants, the productions, and articles of merchandise.

1. *Shaping the Course in a Current.*

942. When the whole or any part of the voyage lies through a current, having everywhere the same direction and velocity, it is proper to shape that course which shall keep the port on the same bearing (No. 294), because the ship will thus cross the current in the shortest possible time. But if the current be different in different parts of the voyage, this rule does not hold good. This point cannot be pursued further in this volume.

When the current, setting the ship away from her port, is so strong, or the wind so light, that the ship cannot preserve the bearing of the port unaltered, she will be kept so that the course made good shall not be more than eight points from the bearing of the port; because, though she cannot thus near the port till circumstances change, yet she will not increase her distance from it, as would result from shaping any other course.

The application of all such rules must, accordingly, depend upon the circumstances of the case.

943. When the ship, having a foul wind, is in a current of which the direction and rate are known, she should be kept as much as possible on that tack on which the current tends most to drift her to windward, or is least unfavourable in drifting her to leeward.

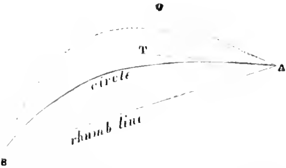
For example. Suppose the course to be steered is S.W., the wind S.S.W., the current S.S.E., 2 knots. Then, on the larboard tack, lying west, and going, suppose, 6 knots, she will make good S. 70° W. 5·5 miles, No. 292. On the starb. tack, lying S.E. and going 6 knots, she will make good S. 39° E., 8 knots. The distance made good *in the direction of the port* when her head is S E. is 0·8 miles per hour, No. 285; when lying west, this quantity is 5 miles.

In this case the current tends to drift the ship to windward on both tacks; but the larboard tack is the most favourable.

2. *Shaping the Course on a Great Circle.*

944. When the ship sails on the arc of a great circle, the distance traversed in passing between any two points in her track is (as observed in Nos. 336, &c.) less than if she had sailed on a rhumb-line. A distinction of greater importance between these two tracks is, however, that every point of the great circle lies in a higher latitude than any point, having the same longitude, on the rhumb-line. Thus, if two ships sail from St. Helena to C. Horn, the one upon the great circle, and the other on the rhumb-line, altering their longitude by the same quantity, the ship on the circle will be 440 miles to the southward of the other, when the two vessels are most widely separated; that is, when the vessel on the circle is at the point of maximum separation latitude (No. 345). Now the difference of distance is only 76 miles in 3740 (No. 337, Ex. 1); whereas the difference of 440 miles in latitude may place the vessels in different winds.

945. A course taken anywhere between the great circle and the rhumb-line will always be attended with at least some saving of distance.



Thus, any course between A B and A T (the tangent of the circle at A, and shewing its direction at that point) gives a distance less than A B. Again, since the circle is the minimum distance between A and B, on the surface of the globe, we may take a series of tracks between A and B on the other or *polar* side of the circle, increasing in length as they lie further from it, till we come to the dotted line which represents a curve *equal in length* to the rhumb. Hence a ship sailing anywhere between A B and A U (the tang. which shews the direction of the dotted curve at A),—that is, through a space nearly *twice* as great as that between the rhumb and the circle,—will still have less distance to describe than that on the rhumb-line. On this principle a partially foul wind may often be turned into a fair one.

Thus, in the voyage alluded to above, the vessel on the circle, instead of passing 440 miles to the southward of the track on the rhumb-line, may pass at nearly this distance to the southward of the great circle, or between 800 and 900 miles to the southward of the rhumb-line; and yet, after all, she may make good a distance less than that on the rhumb-line, while the great difference of latitude may enable her to avail herself, for part of the voyage at least, of winds proper to regions far removed from those crossed by the rhumb-line.

946. When it is proposed to sail on a great circle the course is shaped with reference to the present place of the ship; and, therefore, when she is found to have got off the original line laid down, the course should, strictly speaking, be shaped anew. But, in practice, this will rarely be necessary, since moderate deviations from the course will not sensibly alter the bearing of a distant port, that is, the same course will serve as before.

947. In great circle sailing with a foul wind the ship will be put upon that tack in which she lays nearest the circle. The rule for windward sailing, which directs that she should be put on that tack in which she looks best up for her port (No. 299), is, therefore, strictly applicable. Indeed, it is only on laying down the great circle, which alone shews the real direction of the port, that it can be decided whether the wind is foul or not for a distant port.

If the rhumb-line differs more than two points from the circle, it is evident that, by shaping the course on the rhumb-line and then laying the ship on the wrong tack, she will head more than eight points away from the true direction of the port, while on the other tack she would lie within less than 4 points of the course. Thus a seaman not acquainted with the principles of great-circle sailing may cause his ship to recede from her port instead of nearing it.

948. If the wind, when contrary, is in the direction of the great circle, one tack is as good as the other, and the selection must depend on the current, probable change of wind, or other circumstances. The ship should not, however, deviate from the circle so far as to have to shape a new course, for if she has much deviated from that line which was the shortest possible, she must have altered her position for the worse.

950. In navigating the ship on a great circle, in high lats., the course should be shaped anew at each 60 or 80 miles of distance.

The place of the ship is necessarily brought up by middle latitude or Mercator's sailing.

A modification of great-circle sailing has received the name of Composite Sailing. It presents itself whenever the great-circle track, by passing too close to the Pole, becomes dangerous or impracticable on account of the ice which pervades those high latitudes. When this occurs, some one parallel of latitude is fixed upon for the maximum; then the shortest route, under these circumstances, will consist of a portion of that parallel and of parts of the two great circles which touch it and which pass—one through the ship and the other through the destination. This combination of great-circle sailing and parallel sailing offers, therefore, no difficulty. *See* Davis's Star Azimuth Tables, p. 136.

Log, Course, and Dead Reckoning. See Nos. 956 to 969.

951. Dead reckoning has not always met with the attention it deserves. Dead reckoning is a fine art, dependent first upon a well determined position to start with; secondly a knowledge of the correct Variation and Deviation, or total error of the compass steered by; and thirdly on good steering and logging, to carry it on. Remember the remark of John Davis, the navigator, written in 1607, "*the stredge* * *may be so disorderly handled as that thereby the Pylote may be abused.*" Dead reckoning is also dependent on a correct knowledge of probable currents and tidal streams, on the winds that have been and are blowing.

952. *Good Dead Reckoning* can be attained by practice. See note (Rennel's) on p. 353, 359. Let the position by dead reckoning be considered a serious matter, to be carefully compared with the position obtained by observation. If there is a difference between the positions, let that difference be accounted for, and if it exceeds that probably caused by weather, or by known tides or currents, let it be considered that the distance has been wrongly estimated, or the errors applied to the compass courses incorrect, or the ship badly steered. (*The stredge disorderly handled.*) Let more care be taken the next day, and so on until a confidence is engendered in the dead reckoning that may be useful in closing the land in thick weather.

* "Stredge" may stand for stretch, a term for a ship's course.

II. Place of the Ship.

I. *By Dead Reckoning.* *See Nos.* 951, 952.

[1.] *Keeping the Dead Reckoning.*

954. *Latitude D. R.* The latitude by D. R. is deduced by applying the difference of lat. made good by the ship to the lat. by observation of the preceding noon.

When the latitude was not observed at noon, but at some other time it is proper to note the lat. D. R. as "brought up;" because the lat. by D. R., when employed for comparison with the observation, is of course considered as referred to the beginning of the day, unless the contrary is expressed.

When, however, there is no observation, the lat. by D. R. must be referred to the lat. D. R. at the preceding noon.

955. *Longitude D. R.* The longitude by D. R. is deduced by applying the difference of longitude made good to the long. D. R. of the preceding noon.

The long. by D. R. is usually carried on till a new departure is obtained, because the observations for longitude are not so decisive as those for latitude; for the chronometer may alter its rate, and the moon's distance from a star, or her R.A., may be much affected by a small error of observation. Hence, when the longitude by a single observation differs much from the account, it is not always considered safe to adopt it until it has been confirmed by another observation.* When, however, such confirmation is obtained, or two distances, observed at the same time on opposite sides of the moon, give results not differing much from each other,† the resulting

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* In vol. i. of the East India Directory, Horsburgh gives an example of the danger of trusting to a single chronometer for a length of time, or to a single lunar, in the case of the Taunton Castle, which got aground in the Straits of Mozambique in 1791. A lunar 5 days before had agreed with the chron., but a lunar 12 hours before differed from it 1°. It was naturally considered that the former lunar confirmed the chron., and that the later observation was erroneous; the contrary, however, turned out to be the case.

† Horsburgh states that he has found the mean of two lunars, observed on opposite sides of the moon, nearly a degree in error. So strange a result would seem, however, to throw doubt on one of the observations.

The Rev. G. Fisher, in the Appendix to Captain Parry's second voyage, p. 282, states that the mean of 2500 lunars observed in December differed 14′ from the mean of 2500 observed in March following; and that the mean of the observations made in the same summer differed 10′ from these last, or 24′ from the first. Capt. King, in his survey of Australia, notices a discrepancy of a similar kind, to the amount of 12′, at the Goulburn Islands.

longitude should be taken as a departure from which to carry on the D. R.

Although it is recommended not to alter the long. by D. R. on slight grounds, yet it can answer no useful purpose to persevere in carrying it on after observations have proved it to be wrong.

[2.] *Errors of the Dead Reckoning.*

956. These are the errors of the course and distance, with their effects upon the lat. and long. by account.

An error of half a point in the course is equivalent to an error of $\frac{1}{10}$ in the dist. run, very nearly.

957. *Error of the Course.* The ship, besides moving in a path more or less serpentine from the action of the waves, and from imperfect steerage, is driven bodily by the wind, and often by currents and tides; hence the general direction of the ship's head is a very imperfect index of her course by compass. Again, the course by compass is affected by the variation and by the deviation; the latter, as already remarked, varies in different ships, and in different positions of the same ship.

960. *Error of the Distance.* The rate of sailing varies, from time to time, with the strength and direction of the wind, the quantity of sail set, the trim of the sails, the running of the sea, and, in a slight degree, on the skill of the helmsman. Hence, since the log can be hove at intervals only, while the compass is constantly inspected, the distance run, unlike the course steered, is left in a great degree to estimation.

While a vessel is steaming, her rate is, of course, less liable to change.*

961. The allowance to be made for the *heave of the sea* is doubtful. As regards the motion of the waves alone, it would appear that no such action takes place, and any effect of the kind must be referred to the progressive motion which the water at the surface acquires from the action of the wind, and which affects both the vessel and the log. The existence of a surface-current accompanying a strong wind is established by the falling over or breaking of the tops of the waves, which subsides accordingly with the wind, and disappears long before the swell goes down.

962. In steam-vessels the log is found to give too much distance. This is accounted for thus:—The water at the surface being continually urged astern by the paddle-wheels, preserves its motion for some time after the vessel is past; the log, therefore, unless thrown perfectly clear of this current, is carried in the direction opposite to that of the vessel. On this account it is proper to heave the log from the paddle-boxes.

* By practice seamen learn to estimate the rate of sailing within half a knot, and the number of revolutions in a given time of the engines of a ship under steam furnish a means of determining her speed very closely.

963. In consequence of the fore and after bodies of vessels in general being dissimilar, the resistance of the water to the rolling and pitching produces unequal actions on the bottom, from which results a slow motion of the vessel herself in the direction of her length. The nature and quantity of this motion is determined by the form of the bottom. Most vessels forge ahead, but some astern.*

964. *Error of the Latitude D. R.* This is composed of the errors of the course and distance.

If the lat. by D. R. does not agree with the observation, it is customary, when the course since the observation is nearly N. or S., to attribute the error to the distance; because, in this case, any small variation or error in the course will not affect the D. Lat. Again, when the course is nearly E. or W., such error is attributed to the course; because, in this case, a small error in the course will affect the D. Lat., while a small error in the Dist. will not.

These suppositions, though plausible, are not always true, and therefore are not to be implicitly adopted.

965. An error in the latitude is the same number of nautical miles in all parts of the world.

966. *Error of the Longitude D. R.* This error, when the long. is carried on by parallel or by mid. lat. sailing, is proportional nearly to the error of the Dep. When the long. is carried on by Mercator's sailing, the error is due to an erroneous course and distance, and also, in most cases, to using latitudes by observation inconsistent with the given course.

967. An error of a given number of minutes of longitude (′) is the same number of sea-miles† when the ship is near the equator; but in higher latitudes the same number of min. of long. is equal to a smaller number of sea-miles. Hence precision in the longitude is of less consequence to the safety of the ship in high than in low latitudes.

For the same reason the long. by D. R. will in general be kept more correctly in low than in high latitudes.

968. As regards the probable *amount* of the errors of the ship's place in latitude and longitude, it may be supposed that the error of the course will rarely amount to a point, and that the distance will not be in error more than $\frac{1}{10}$ of itself.‡ Such estimations, however, must depend entirely on circumstances.

The error, on the whole, will be that due to the sum or the difference of these errors; more frequently, however, to their differ-

* Capt. W. Ramsay informs me that the *Black Joke*, a very fast vessel which he commanded on the coast of Africa, always forged astern in a calm.

† Seamen are in the habit of calling minutes of longitude *miles*; but a mile is a measure of invariable length, while a min. of long. is different in different latitudes; the practice, therefore, should not be followed.

‡ Rennell ("Investigation of the Currents of the Atlantic," p. 70—London, 1832) quotes Flinders's opinion that the reckoning may be kept within 5 miles of distance, and half a point in the course.

ence, since experience establishes that, when several observations are taken together, their errors tend to compensate each other.

969. Under the head "D. R." is included the determination of the ship's place by bearing and distance of the land. When a point of land bears N. or S., the diff. lat. of the point and the ship is the distance; and consequently the error of the lat. is exactly equal to that of the distance, while a point or two of error in the bearing produces but small error in the lat.

On the other hand, if the place bears E. or W., the ship's lat. is that of the point itself, and an error in the bearing produces in the lat. an error proportional to her distance.

This applies to longitude by reading, in the above, long. for lat., and interchanging N. and S. with E. and W.

[3.] *Variation of the Time at Sea.*

970. When the ship sails to the eastward, she meets the sun, and therefore anticipates the hour of the day by a portion of time equal to the diff. long. she makes good. In sailing to the westward, the contrary takes place. Hence in sailing eastward the apparent day is always less than 24 hours, and in sailing westward greater than 24 hours, by the diff. long. made good, in time.

Thus a ship, in sailing round the world to the eastward, gains a day in her reckoning of time: for each day in which her head is to the eastward is less than the common day of 24 hours by the diff. long. made good; and this goes on till the diff. long. has accumulated to 360°, or 24 hours. Hence, on completing the voyage (but without any relation to the time of performing it), the ship, by constantly gaining on the next day, is found to have completely anticipated it; so that, instead of finding it Wednesday, for instance, among the natives, it appears by her journal to be Thursday.

In sailing round the world westwards, the ship in like manner loses a day. In these cases the voyage is performed in days of a different length from the average of 24 hours, and the whole period is made up of a different number of days.*

971. This alteration of the date in the journals of ships crossing the Pacific is often attended with considerable embarrassment to the reader, especially if he does not bear in mind the direction of the ship's route. In order to provide against this ambiguity, the navigator should insert the Greenwich Date at full length, in every case in which a reference to the absolute time may be required.

972. The variation of time, or the irregularity in the length of the day, falls on the hour or half-hour preceding noon, the last glass

* Sir James Ross remarks that in crossing the meridian of 180° eastwards they made two Thursdays, and two Nov. 25ths, by which means their reckoning would correspond to that of Australia and England on their arrival.

A short rule to estimate day and hour of arrival for steamships crossing the Pacific is: Going West: Add one day to assumed time of length of passage, and subtract the Diff. Long. *in time* between the two ports. Going East: Subtract one day from assumed time of passage, and add the Diff. Long. *in time*.

or two not being turned. When there is no observation for some days, the time is thus liable to be considerably in error.

This uncertainty in the absolute time causes no difficulty in bringing up observations to noon, or to any other time, nor in connecting observations made A.M. with others made P.M., because the courses and distances marked on the log-board are those corresponding to the actual intervals elapsed.

973. It is evident, since the time at ship always has reference to the diff. long. made good subsequent to the observation for time, that the account of the time is more correctly kept in low than in high latitudes. (See No. 967.)

[2.] *Place of the Ship by Observation.*

974. Besides the latitude and longitude of the ship by observation, we shall consider, under the above head, those observations from which the elements necessary in the calculation of her place at any time are obtained: as observations for Time, and for the Variation of the Compass.

[1.] *Latitude by Observation.*

975. In variable climates it is often advisable to take, early in the forenoon, an altitude of the sun, to be followed by another after the proper change of azimuth, No. 749, for a double altitude, in case the meridian alt. is not obtained.

If the second alt. is observed within the limits of Table 47, the operation is simpler, and the result more satisfactory. If it is near the meridian, and the time is not very much in error, the second alt. alone determines the latitude by the reduction to the meridian, p. 249.

In either of these cases the first alt. affords the apparent time, when the lat. has been ascertained.

976. (1.) The lat. will of course be obtained, when possible, by the meridian altitude of the sun. The short double altitude A.M. has the advantage of providing against the loss of this observation,* and it enables the navigator to determine the place of the ship before 12 o'clock.

The altitude of the moon on or near the meridian (Nos. 702, 703) may often be obtained during bright sunshine. Also, the moon's alt., combined with that of the sun, affords the lat. by double alt., No. 759, &c.

The planet Venus may often be observed during the day.†

* The only observation disturbed by the ship's change of place (No. 548) is the mer. alt. Suppose, for ex., the ship is approaching the sun 12 knots, she raises him at the rate of 12″ in 1^m. Hence he continues to rise till he is so far past the merid. as to have begun, by his motion in altitude, to fall at this rate. In high lats. where the motion in alt. is slow, the interval will be considerable; in lat. 60 he would appear to dip about 5 min. P.M., and in the same case, with the ship receding from him, he would dip about 5 min. A.M. To compute this time, see No. 622.

† Horsburgh states that he has observed the meridian alt. of Venus, at the Cape of

When the planet is not bright enough to be distinctly visible to the naked eye, it may generally be found, when near the meridian, thus:—Compute the merid. alt., No. 663; add to it the dip and refraction; set this angle on the sextant, put in the inverting telescope, screwing it close down to the plane of the instrument: then, directing the sight to the N. or S. point of the horizon, the planet should be seen in the silvered part of the glass.*

977. The lat. is found at night by observations of stars on or near the meridian, No. 687. The lat. by a star at night not only is useful in preventing the accumulation of error in the D. R., but also serves as a check on the lat. by the sun (note *, p. 249).

The observation of stars at night is, however, a very different observation from other altitudes by day, and, to ensure success, the observer should make it a matter of special practice.

It is, however, during the twilight that stars and planets may be most advantageously observed at sea, as the horizon at that time is strongly marked, and, when not sufficiently so, may be rendered distinctly visible by the inverting telescope. In favourable cases such lat. may be depended upon with as much confidence as that of the sun. In north latitudes above 20° or 30°, the pole-star may always be observed when the sky is clear.

[2.] *Time by Observation.*

978. The Time is generally found by a single altitude (p. 278), early in the forenoon, when the error of the ship's lat. produces no sensible error of time. It should also be found late in the afternoon. In certain cases it may be found by equal alts., No. 798, the result of which is apparent noon; and also approximately by the short double altitude (p. 285), and at sunrise and sunset (p. 283).

The time may likewise be deduced from one of the altitudes of a common double altitude (p. 276); but the latitude resulting from this observation not being very correct in general, and more especially when the reduction of the alts. to the same place of observation is large, the time deduced would not always be satisfactory.

979. When the sun and moon are both visible, and one of them is near the meridian, the lat. may be found, and also the time, which (Nos. 696, 757) thus has the advantage of being free from the errors of the reckoning. In like manner the alt. of a planet might be taken with that of the sun at the same instant, or some time afterwards (No. 764).

980. When the time is found at night by alts. of stars or of the moon (Nos. 782, 784), since the sea-horizon is often unfavourable for observation at that time, the result should be considered as of

Good Hope, during bright sunshine. Capt. Basil Hall, to whom I am indebted for several valuable suggestions, acquainted me that, on a voyage to Malta in H.M.S. Indus, in August 1841, he observed the mer. alt. of Venus every day for a fortnight. Capt. Wickham also tells me that he has found the lat. by Venus, in the tropics, at 3^h in the afternoon.

* Capt. Hall informed me that he had often found the lat. in this way, both by Venus and Jupiter, when the planets were altogether invisible to the naked eye.

inferior value; or stars should be observed on both sides of the meridian, in order to diminish the effects of errors from this cause.

The remarks on the observations of planets or stars by twilight for lat. (in No. 977) apply to observations for time. Stars may often be obtained nearly on the prime vertical, and on opposite sides of the meridian (No. 787); and the alt. for time should always, if possible, be accompanied with another for lat., in order to avoid all reference to the reckoning.

981. An approximation to the apparent time may be conveniently obtained, during part of the six months that include the summer, by setting the index of the sextant to the apparent alt. of the sun's lower limb deduced from the true alt. of the centre, at the time of passing the prime vertical, Table 29; the hour angle at which the limb attains this alt. is then taken out from the adjacent column.

982. Since the change of alt. of any celestial body is greatest at the equator and nothing at the pole, the time deduced by means of altitudes is more correctly determined in low than in high latitudes. (See Nos. 778, 779.)

983. Advantage should be taken of favourable opportunities of landing at well-determined places for good observations of time, because the diff. long. between the places will at once discover any considerable change in the rate of the chronometer, and afford the means of correcting it. Comparatively few places indeed are as yet laid down with sufficient accuracy for the general practice of this simple and decisive method; but, in proportion as the longitudes approach to precision, the differences of longitude will be employed by seamen as the means of obtaining, directly, the *sea-rates* of their chronometers, instead of waiting to obtain harbour-rates.*

984. *Error of the Time at Sea.* The time at sea, as found by a single altitude, can rarely be depended upon to less than 10^s (Nos. 778, 779). If, therefore, the ship's reckoning were correctly kept, her diff. long. applied to the time, as found by observation on a former occasion, would give the time at ship within about 10^s of the truth. But as the D. R. is always more or less in error, and as the error may be considered generally to increase with the time elapsed, the error of the time at ship may be considered as 10^s *plus* the error of the diff. long. accumulated since the observation.

[3.] *Longitude by Observation.*

985. The longitude by chronometer may be ascertained whenever the time is obtained. The long. by chron. is thus the most efficient check on the long. by account from time to time; but after a lapse of time it may be greatly in error, as the rate is liable to change. See No. 531.

* This important remark is due to Col. Sabine, "Account of Experiments," p. 401.

When there is no chronometer on board, the longitude by D. R. can be corrected only on making the land, or by a lunar observation, or sometimes by speaking another vessel.

986. When a satisfactory longitude is obtained by independent means, as by observation of the moon, it should be adopted as a new departure taken at the instant of observation, instead of carrying it back to the preceding noon or any other time; because this last process, which is attended with no advantage, impairs the value of the observation by mixing with it the errors of the run.

987. Since the object of the lunar observation is to find the mean time at Greenwich at the instant of observation, the simplest and most direct application of the method is to find at once the error of the chronometer on G. M. T.; because this process is not embarrassed by consideration either of the time at place, or of the change of long. in the interval between the lunar observation and the observation for time. This is the practice of the most experienced navigators.

988. When there is no chronometer on board, the longitude itself must be found for the instant of the mean of the observed distances. For this purpose the time at place is necessary. If, therefore, either of the altitudes observed for the lunar is favourable for determining the hour-angle corresponding, the time may be obtained from it, and being compared with the G. M. T. found by the lunar, the long. is determined, No. 827.

If neither of the altitudes is fit for the purpose, the time must be found as soon as possible afterwards. In this case, add the interval elapsed to the G. M. T. deduced by the lunar: the sum is the G. M. T. of the observation for time. This time, compared with M. T. at place, gives the longitude.

Ex. At $3^h\ 11^m\ 26^s$ by watch, obtained a lunar, which gave G. M. T. $2^h\ 14^m\ 32^s$. At $3^h\ 56^m\ 18^s$ by watch, obtained an observation for time. Find G. M. T. at this second observation.

T. by watch, of lunar	$3^h\ 11^m\ 26^s$	G. M. T. of lunar	$2^h\ 14^m\ 32^s$
Ditto of obs. for time	3 56 18		44 52
Interval	44 52	G. M. T. at 2d obs.	2 59 24

989. In the Arctic regions, in summer, the presence of the sun at night prevents the stars from being seen; also frequent fogs obscure the moon. Hence the lunar observation is much less available there than in other climates, and the chronometer in consequence more valuable.*

990. The number of observations, either for latitude or longitude, which it may be proper to take for determining the ship's place, obviously depends on the distance of the land and on the state of the weather. For example, in making a passage with a trade-wind, a much less degree of attention will be necessary than in unsettled weather, when the D. R. cannot be kept with equal correctness,

* "An Account of the Arctic Regions," &c., by W. Scoresby, jun. 2 vols. Edinburgh, 1820.

or than when the ship is in the neighbourhood of the land or a danger.*

It is always advisable, when any observation is taken, to obtain, either at the same time or as soon as possible afterwards, another of such a kind that the same error may produce different effects on the result; whereby the two results being in error opposite ways, their mean will be preferable to either separately. The kind of observation proper for this purpose, in any case, has been generally noticed in the *Degree of Dependance*. See No. 999.

When the observation consists of one or more alts., the errors of observation may often be removed at sea by observing also the supplement of the alt. It is, however, proper to remark, that when the supplement is observed by an ordinary sextant or circle, it is, in consequence of its greater magnitude, much more affected by the error of parallelism (Table 54), when this is considerable, than the alt. itself.

[4.] *Observations for the Variation.*

991. The total error of the standard compass should be constantly observed and recorded, not only for the purpose of secure navigation, but with the view of determining the variation, and so helping to maintain, for the benefit of all seamen, a correct chart of its value.

993. The amplitudes of bright stars and planets may often be well observed, especially about twilight, when the horizon is strongly defined. The observation is most convenient at setting, because a star may be followed to the place of its final disappearance below the horizon; but it is not always easy to identify a star at rising.

With care the error of the course due to the compass alone should not exceed a degree: less accuracy is hardly compatible with good navigation in fast steam-ships.

[5.] *Combination of Results.*

997. As all observations are liable to errors, and as given errors of observation produce different effects according to the case, the results of different observations do not generally agree.

In some cases the same errors of observation will cause all the results obtained under the same circumstances to be in error the same way, instances of which occur in Nos. 702, 868. In other cases, the effects of errors will tend to compensate.

998. In general, when the particular errors with which the observation is affected are not known, the *mean* of the several results is employed, or the sum of the results divided by the number of observations.

* Rennell remarks that the facilities afforded in these days for finding longitude may tend to diminish the *necessary attention to the reckoning*, on the ground that the next day's observations will set all right. P. 79.

Since one of two results may be nearly or exactly true, and since it will rarely happen that one is precisely as much too great as the other is too small, the mean of two results will generally be merely less in error than the worst.

999. In taking the result of observations affected by the same *constant error*, care must be taken not to mix those of opposite kinds, as N. and S., or E. and W., but to take the mean of the two different *results*. For Ex.: Suppose the lat. is 1° 28′ by each of two stars N. of the zenith, and the instrument has a constant error of 1′, then the lat. by one star S. will be 1° 26′, and the true lat., 1° 27′, is the mean of 1° 28′ and 1° 26′. But the mean of the *three* results, taken promiscuously, or one-third of 1° 28′, 1° 28′, and 1° 26′, is 1° 27′ 20″, which is not right.

The same would be true, however great the number of observations on one side, or however small on the other; and hence it is always proper to make this separation, which is also a means of detecting a constant error. For instance, if the moon's semidiameter in the Naut. Alm. is erroneous, the result of lunar observations of one limb will differ from that of observations of the other limb and the mean of the two results, not of the whole indiscriminately, will afford the true longitude.

1000. When the error of observation is given, the *amount* of the error of the result may be computed. Examples of this have already been given in most of the rules for the *Degree of Dependance* Again, the effect of a constant though unknown error of observation may sometimes be removed, as in No. 861, where the same error in each distance produces more or less error in long., exactly in proportion as the moon's motion in respect to each star is less or greater.

1001. When some of the several results of different observations are known from circumstances to be better than others, it is proper to give to the superior results a greater weight or influence in the general determination. This is effected by writing them down oftener than the others, and dividing the sum by the number of results thus augmented. For example, suppose a diff. long. by a chronometer A is $1^h\ 11^m\ 18^s$, and by another, B, it is $1^h\ 11^m\ 23^s$; and suppose the result of A is estimated from its superior performance, or other circumstances, as half as good again as that of B, that is, of superior value in the ratio of 3 to 2; then, writing down 18^s three times, and 23^s twice, and dividing by the sum of 3 and 2, or 5, gives 20^s, or the estimated result, $1^h\ 11^m\ 20^s$.

The preference of any one result to another under the same or different circumstances, or the degree in which one may be supposed superior to another, must be left to that judgment or tact which is the result of experience and constant attention to a particular subject, as it is obviously impossible to lay down rules of certain application for such questions.

1002. Though it usually happens that the mean of several observations is near the truth, yet, as this is not certain, we must not hastily assume that the mean of even a very considerable number is a definite determination.*

It is proper to bear in mind that the chronometers, when they agree, are either all right or all wrong; but that when they disagree, some of them must be wrong.† See No. 531.

1003. We shall here remark, also, that every determination whatever is liable to the suspicion of having been influenced by the premature adoption of an approximate mean. For ex.: an observer collects 6 or 8 observations; 2 or 3 of these differ widely from the rest, and they are rejected forthwith. Succeeding observations are compared with the mean, and admitted or rejected accordingly. Now these outlying observations may happen to be as good as the others, if not better; but by this partial suppression of evidence the question is prejudged, and the increasing number of observations only tends to fix the erroneous determination more firmly.

3. *Laying off the Ship's Place on the Chart.*

[1.] *Position in Latitude and Longitude.*

1004. As the account of the ship's place is closed at noon, the ship is pricked off at that time; also at 8 P.M., when the course is shaped for the night.

The ship's place is laid down by observations, when these can be obtained; in other cases it depends upon the D. R., or frequently upon both.

1005. It is the practice of some seamen, besides taking the ship's place by obs., to mark also her place, as brought up by D. R., from her former position by observation; a line joining these two points stands thus as a leg apart from the ship's track. When the ship stands nearly on the same course, and carries the same wind for some time, this method has the advantage of exhibiting any constant effect produced by a current, or by local deviation, or arising from not making a proper allowance for lee-way.

1006. Since the determination of latitude is absolute and independent (No. 680), the lat. of the ship should be marked whenever a satisfactory observation is obtained.

1007. The longitude, when determined by chron., should be marked on the chart for the time at which the observation is taken, because thus it is unmixed with the errors of the run.

It may be prudent, when there is but one chronometer on board, and when observations of the moon are not practised, to assign a

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* Capt. Fitzroy's chronometric measures, the results of 20 or 25 chronometers, amounted, when added together, to $24^h\,0^m\,36^s$, or 36^s more than the entire circumference. This seemed to be considered, at the time, as a somewhat curious circumstance; but it is evident that some excess or defect was to be looked for, since nothing but accidental compensation of errors could produce, out of a number of discordant elements, the precise quantity $24^h\,0^m\,0^s$.

† Adm. Beechey acquainted me that on one occasion all his chronometers agreed within 1′, being nearly 30′ in error, and that the single chronometer of the Starling, the tender, was right. As the large majority was considered conclusive, the error was near leading to serious consequences.

second track to the long. by D. R. alone, in intervals of making the land.

1008. As a tolerably good watch alters its rate but little from day to day, the ship's track, as laid down by chronometer, represents truly the relative positions of the ship at different times, and therefore exhibits nearly the true *figure* of her track for a few days together; while its absolute position in *long.* may, at the same time, be erroneous, if the error on G. M. T. is not well known.

On the other hand, since the longitude by lunar, though of undoubted value, is not susceptible of much numerical precision; the difference of two longitudes by lunar, separated by an interval of time, will not, in general, agree with the diff. long. as measured by a chronometer. Hence the track of a ship, as laid down by lunars, would exhibit violent irregularities of figure, while its absolute position in longitude would not be very far from the mean of all the lunar determinations.

Accordingly, when the long. by chronometer is proved by lunar observations to be much in error, and it is required to correct the position of the ship's track, it will be proper to take a mean position among the several positions by lunar, and the lat. at the last lunar. This point being assumed as a departure, the track for the time previous may be adjusted.

*Sumner's Method.**

[2.] *Position on a Line of Bearing.*

1009. When the lat. by acc. is uncertain, the resulting long. by chron. is uncertain in a corresponding degree; but this long., far from being valueless, is capable of an important application, especially when the ship is near the land.

Suppose a second lat. by acc. near the first, as, for ex., 10′ greater, a second long. by chron. will be found corresponding; in like manner we may suppose a third lat., with its corresponding long., and so on. Now these positions are those points in different latitudes at which the *same alt.* is observed, and constitute the curve or *circle of equal altitude*, since the observer, moving over the globe so as to keep the sun always at the same alt., would move on a circle, the pole of which is that point where the sun is vertical.

The small portion of this curve passing through two positions near together would appear, on the chart, a straight line; and thus, if this line (being produced) passes through a point of land or other object, the *bearing* of such object is known, though the ship's *place* on the line of its direction is not known.

1010. The process of finding the line of equal alt. consists thus in

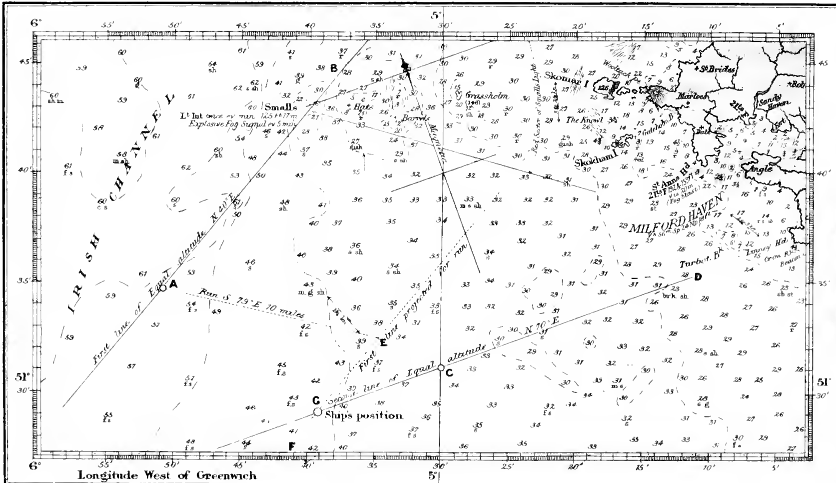
* "A New and Accurate Method of finding a Ship's Position at Sea," by *Capt. Thos. H. Sumner.* Boston, 1843.

In 1843, Commander Sullivan, R N, not having heard of this work, found the line of equal alt. on entering the River Plate, and identifying the ship's place on it, in 12 fathoms, by means of the chart, shaped his course up the river. The idea may thus have suggested itself to others; but the credit of having reduced it to a method, and made it public, belongs to Capt Sumner.

DIAGRAM

To illustrate Sumner's method for finding the position of a ship at sea.

To face p. 363



ALL BEARINGS ARE TRUE

assuming two lats. by acc., finding the long. by chron. corresponding to each, laying off these two positions on the chart, and joining them by a straight line. But since the sun's bearing is 8 points or 90° from the direction of the line of equal alt., this line may be expeditiously obtained from one obs. only, by drawing a line through the assumed position of the ship at right angles to the sun's azimuth at time of obs., as found by Chap. VII. p. 240; or from the Azm. Tables of Burdwood or Davis.*

From a second obs. of the same or different bodies taken at a suitable difference of bearing, another line of equal alt. is similarly obtained. The intersection of these two lines gives the position of the ship supposing the ship not to have changed her position in the interval.

1011. When the ship changes her place the *true* course and distance made good must be laid off from the first assumed position. Through the point thus found a line must be drawn parallel to the first line of equal alt. Where this line cuts the second line of equal alt. will be the ship's position at the second obs.

The difference of bearings of the sun or bodies used at the two observations should not be less than 25°, or the lines of equal alt. will cut too acutely.

Example, see Diagram.

In the Irish Channel, August 18th, 1890, at $9^h\ 36^m$ A.M., in lat. by acc. 51° 35′ N. the long. by obs. was 5° 51′ W., and the sun's true bearing being N. 130° E., the direction of the line of equal alt. A B, drawn through position A, was N 40° E.

At $11^h\ 8^m$ A.M., in lat. by acc. 51° 31′ N., the long. by obs. was 5° 30′ W., and the sun's true bearing being N. 160° E., the direction of the line of equal alt. G C D, drawn through position C, was N 70° E.

The run of the ship in the interval (A E) was S. 79° E. *true*, distance 10 m.

Through E the line E F is drawn parallel to A B; this line cuts the line C D in G. G is the position of the ship at the second obs. in lat. 51° 29′ N., long. 5° 39′ 30″ W.

1012. As the ship must be somewhere on the line of equal alt. drawn upon the chart, if this line falls upon a well-sounded chart, her position may be approximately known from the depth of water obtained at the time of obs. Thus on the line A B a depth of over 50 fms. would shew the ship to be at a safe distance from the Smalls. Similarly on the line C D a depth of 40 fms. shews her to be about 23 m. from Linney Head. The line of equal alt. at the first obs. should therefore be drawn as soon as the observations are taken and worked.

When the coast trends parallel to the line of equal alt., the distance of the ship from the shore is ascertained, though her absolute position is uncertain.

1013. The lat. assumed should be as nearly correct as can be obtained by D. R.; this is important when the alt. is high. In low latitudes, when one obs. falls within the limits of the problem for finding the lat. by Reduction to the Meridian (see Table 47), this method should be used in preference to "Sumner's."

* The line of equal alt. may be found by the change in hour angle and consequent change in long. due to a change of one mile in lat. found by No. 615.

1014. As the sun rises and sets to half the globe, the circle of equal altitude at rising and setting is the entire circumference. On the other hand, when he is in the zenith, this circle is reduced to a mere point, or, for opposite points of the sun's disc, covers 32 sea-miles. When the alt. is 89° 50′, the radius of this circle is 10′, or its extent is 20 miles; when the alt. is 50°, the radius is 40°, or the extent 80°. Thus when the sun is low this circle is large, the small portion of it comprised between two assumed lats. very nearly a straight line, and the sun's azim. the same from both ends; but when he is high the circle is small, a small portion of it may be much curved, and the direction of the two extremities very different; that is, the bearing of the land, and the sun's azimuth, may be sensibly different from different parts of the same portion. An error in the assumed lat. has therefore most effect when the alt. is high, and least when it is low, which last is consequently always the preferable case.

As the change from or towards the object of 1 mile in the observer's place changes its alt. 1′, the effect of an error of alt. is shewn by moving the line parallel to itself through the same amount.

An error in the chronometer places the line of equal alt. too far E. or too far W., bodily, but does not alter its *direction*.

III. Determining the Current.

1015. The direction and rate of the current are found from the change of place of the ship, or from experiment.

In No. 297 examples are given of finding the current by the comparison of the place of the ship by D. R. with that by observation, and also by reference to the land. In consequence, however, of the unavoidable errors of the reckoning, such determinations must be far from conclusive; and there is no doubt that currents are often assumed to account for discrepancies between the D. R. and observation.* The only decisive method is, evidently, to determine astronomically the place of a floating body, or substance, not exposed to the action of the wind, at intervals of time.

1016. As currents are considered to prevail for a very small portion of the depth of the ocean, it has been recommended to sink a weight to a considerable depth to serve as an anchor for a boat, from which the current at the surface is determined by the compass and the log. This method, however, can obviously discover only the difference between the current at the surface, and that at the depth to which the weight is lowered.

* From good or carefully kept D.R. a reliable Current in 24 hours may, however, be often obtained.

IV. Making the Land.

1029. When confidence cannot be placed in the correctness of the longitude, it is proper, if circumstances permit, to make the latitude of the port, and then to run on the parallel for it.

1030. On approaching the land it will be prudent to charge the ship's place with some inaccuracy; and the best reckoning can never supersede the necessity of a vigilant look-out.

1031. When the land is made, the ship's place should at once be laid off by the reckoning; for the reckoning may be good, and if so, the ship's position, as laid down, will be correct, or nearly so.

And, again, it is not uncommon, on making the land, especially in defective light, or on a new bearing, and consequently under an unaccustomed aspect, to mistake one point for another, or to make a considerable error in estimating the distance. Now the position laid down is that by which the ship's course is shaped on the chart, and if it depends on an erroneous bearing or distance, it may lead her too near the shore or a danger. The effect of moonlight is generally to make land appear more distant than it really is.

1032. Navigation among coral reefs is facilitated by the clearness of the sea-water. On the reefs on the east coast of Australia, a depth of 5 fathoms was seen from the mast-head, at the distance of half a mile; in 7 fathoms a patchy bottom was well made out from the boat's gunwale; but in 10 fathoms the bottom was scarcely distinguishable from the dark blue of the open sea.

1033. In navigating among coral reefs it is recommended, as essential to safety, that the day should be clear, the sun behind the ship, the water low, and, when the shoals are not clearly distinguished, that the ship should anchor if possible. When the sun draws ahead, coral patches become less distinct; and hence caution is necessary, when making for coral reefs with the sun ahead of the ship.

It is also remarked that the look-out, when placed half-way up the rigging on these occasions, sees better than from the mast-head, where the eye is dazzled by the glare.*

When approaching to round a point of land or shoal, and for that purpose bringing it on what appears a safe angle on the bow, care must be taken that the danger is brought aft—that is, that its angle on the bow is increased as the ship goes on. This is

* When looking out for a light at night, the fact is often forgotten that from aloft the range of vision is much increased. By noting a star immediately over the light a very correct bearing may be afterwards obtained from the standard compass. The intrinsic power of a light should always be considered when expecting to make it in thick weather. A weak light is easily obscured by haze, and no dependence can be placed on its being seen.

especially necessary with a tide or current on the off-bow. From want of due caution in this respect, a ship having only low speed may get into a position with reference to a danger from which it may be difficult to extricate her. The custom of handling ships from forward makes this caution the more necessary.

From No. 369 it will be seen that the seaman can certainly know when a vessel is outside any projecting or outlying shoal by an angle between two fixed marks on the adjacent land. Thus if A and B (fig. ex. 1) are two marks on the land, and the circle OBA passes through those marks and outside any off-lying danger, then, when the angle subtended by the two marks is less than the angle AOB (in this case 46°) the ship cannot be within the circle OBA. The angle AOB has been called the danger-angle.

Such angles may be most accurately measured with a sextant; but the angle between any two bearings taken with a compass, if the ship's head is kept in the same direction while they are taken, is also correct, the bearings being equally affected by variation and deviation. But if such bearings are plotted as cross-bearings, and either the estimated variation or deviation is erroneous, the position of the ship so obtained would also be erroneous.

When ships were navigated chiefly under sail, seamen were much less disposed to approach the land than now. The certain command of course and speed given by steam has led to closing the land, in order to save distance or for other purposes, in a way which would formerly have been considered unsafe. This practice has not been unattended with loss, from the fact that general charts are made from surveys which were not intended for such close navigation. Harbours and their immediate approaches are generally very closely sounded, but to survey every sea-coast in such detail would occupy very much more time than is generally available. The mere fact that vessels have frequently passed close to the land in certain positions without accident, is far from being such reliable evidence of the non-existence of danger as the close sounding of an accurate survey.*

1034. The supply of *water* is a matter of so great consequence as to justify a slight deviation from formal strictness of design in allusion to it. Most of the places at which water is procured are denoted in Table 10 by the letter w, but there are some general suggestions on the subject which may be highly important on occasions, and which it is, therefore, worth while to collect here for reference, more especially as the various works through which they are seattered cannot be generally accessible to seamen.

(1.) The water carried by rivers into the sea is often found at a considerable distance beyond the mouth. For, a cubic foot of fresh

* Further, though ships now better preserve any given course, and the distance run is estimated more accurately than formerly, there are in modern iron ships elements of uncertainty about dead reckoning which still make it perilous to close the land, unless there are means of knowing *with certainty* when the ship is in dangerous proximity thereto.

water weighs 1000 oz. avoirdupois, while a foot of salt water weighs 1028 oz.; the fresh water is thus lighter than salt in the ratio of 100 to 103, or by 1 part in 34 parts; and hence, when running into salt water, diffuses itself over the surface, where it remains till mixed by the agitating effect of the wind or other causes. Numerous instances are recorded of fresh water being thus found at considerable distances from the shore. Dampier, whose interesting voyages contain sagacious remarks on almost every circumstance that deserves the attention of seamen, relates that, being about 2 miles outside a small river, near Achen, in Sumatra, they "found the water of a muddy grey colour, and on tasting it found it fresh;" and he adds that in such cases "we must dip but a little way down, for sometimes if the bucket goes but a foot deep it takes up salt water with the fresh." A similar circumstance happened to the crew of the Alceste's barge, when conveying Lord Amherst to Batavia, after the wreck of the ship, on his return from his embassy to China in 1817. Ships have watered two miles outside one of the mouths of the Mississippi, the end of the suction-hose being carefully kept just below the surface. On the like occasions it has been observed that the water has been fresh on one side of the ship and salt on the other, the difference (which of course is only superficial) being due, no doubt, to the protection afforded by the ship on one side against the effect of the wind to mix the waters.

(2.) When rain falls on sand contiguous to the sea, the sand protects it from agitation, and it may remain a considerable time unmixed with the salt water. Accordingly, water is often found, especially after a shower, by digging in sand, taking care to remove it slowly; and advantage may no doubt be occasionally taken of the vicinity of a sandy shore or island to recruit water.

The troops being greatly distressed for want of water in Egypt, Sir Sidney Smith pointed out, that wherever date-trees grow, water was to be found; and a hole having been dug by his directions near some trees of this kind, and a cask sunk in it, a supply was obtained.

Adm. W. H. Smyth (in his Memoir descriptive of the Resources &c. of Sicily and its Islands, London, 1824, p. 112) states that on both sides of the Channel (the Faro of Messina), pure, though rather hard, fresh water, is procured, by digging a hole in the sand, within two or three feet of the margin of the sea; this supply is obtained by the filtering of the fiumare (torrents), the beds of which, though apparently dry, are never utterly so. The shores here alluded to are wide and flat, and consist of sand and gravel.

In the sailing directions for the North Atlantic, it is stated that water is always procurable near the Is. de Los, by digging near the root of a cocoa-nut tree. Adm. Beechey describes water as found by digging in the coral rock and recommends selecting the higher spots, distant from the sea. Lieut. Ruxton (Naut. Mag. 1846, p. 12) states that water is procurable, notwithstanding discouraging appearances, at a trifling depth in the sand, on the S.W. coast of Africa, to the northward of Walvisch Bay. Extensive tracts of coast, in different parts of the world, are, however, described as absolutely without water.

(3.) Water is often found by following the track of animals, which, whether wild or domesticated, form paths to watering places. It was by following a path made by goats at Ascension, that Dampier discovered the spring which bears his name. Capt. Fitz Roy states that water was found on Charles and James Islands in the Galapagos by following the track of the terrapin.

(4.) Boats' crews or survivors of a shipwreck may find it useful to know that rain-water and dew collect round the stems of plants which shoot leaves upwards. Dampier (Voyages to the Bay of Campeachy, p. 56) remarks that it is often obtained from wild pines. 'These take root and grow upright from trees. The leaves hold a pint and a half or a quart. We stick our knives into the leaves, just above the root, and that lets out the water, which we catch in our hats, as I have done many times to my great relief."

The cocoanut-tree, the fruit of which is found plentifully, but not everywhere, in the tropics, and chiefly near the sea,* and whose singular and beautiful form, reaching to the height of between 40 and 110 feet, renders it a conspicuous object as a mark, is denoted in Table 10, on account of its value to seamen, by a special symbol. The natives near Cape Grenville, Australia, carry with them, when travelling inland where they are not likely to find water, the juicy roots of a shrub (Naut. Mag. 1847, p. 178). Captain Stokes remarks that a pint of water has been collected by a sponge from leaves in the morning, even on the S. coast of Australia, where the dews are not so heavy as on the N.W. coast (Discoveries in Australia, &c., in H.M.S. Beagle, 1837-43," vol. ii. p. 12).

(5.) Ice islands are frequently composed of pure fresh-water ice, which is found in pools on the surface,† or running down the sides; and watering in this manner is a general practice of ships in icy seas. It is often, however, difficult to land on ice; and in such circumstances Admiral Bellingshausen cannonaded an ice island, and sent the boats for the fragments splintered off.

A peculiar danger is incurred by landing, for the purpose of cutting away a portion, upon ice which, from the advanced period of the summer, or the warmth of the air or sea, tends towards dissolution. A blow of an axe may split the whole mass, and the two portions, in turning over to acquire a new position for floating, may engulph the boat and the persons employed. (Scoresby, Journal of a Voyage to the Northern Whale Fishery in the Baffin, in 1822, p. 300.) A mass of ice is likewise often liable to turn over, to float in a new position, in consequence of having undergone a change of form by thawing irregularly.

The pools of water on the ice are often brackish in the autumn,

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* This has long been remarked. Dampier records that the finest he had ever seen grew on Trieste, a small island off Sumatra, overflowed at spring-tides.

† In about 62° S. the U.S. Expl Exped. found on an iceberg a pond of excellent water, an acre in extent, and 3 feet deep, covered with a scum of ice 10 inches thick.

when the ice becomes porous, and the salt water is drawn up by capillary attraction (Narrative of an Attempt to Reach the North Pole in Boats, by Capt. W. E. Parry, 1827).

Though excellent water is often obtained from ice, it appears by no means certain that this is always the case. Mr. Rae, who left Fort Churchill in July 1846, to explore the coast from "Dease and Simpson's furthest," to Fury and Hecla Straits, states "that they had much difficulty in finding water that was drinkable" (Naut. Mag. 1847, p. 620). Baron Vrangel (Le Nord de la Sibérie, Voyage, &c., 1822, &c.), mentions that the salt left by evaporation on the surface of the ice, is mixed with the snow that falls upon it, and eaten as salt with food, though bitter and aperient. He found the green transparent ice brackish, the blue, fresh.*

1. *Indications of Land.*

1035. The neighbourhood of land is often indicated by the presence of birds, and its position inferred from the direction in which they take their flight at sunset. Birds, however, are often found attending floating masses of seaweed, which they follow for the sake of fish, and which is found at all distances from land.

The sudden appearance of birds flying round the ships at night aroused the attention of the officer of the watch, and was thus the means of saving D'Entrecasteaux's squadron from great danger near New Caledonia (M. D'Urville's Voyage in the Astrolabe, 1826; Paris, 1833, vol. iv.)

Adm. Beechey remarks that birds fly near reefs and islands in the Low Archipelago, and calls the attention of seamen to this circumstance.

1036. It has generally been supposed that the appearance of particular birds denotes the land to be near. Cook remarks (1st Voy. vol. i. p. 53), that "they had been so often deceived that they ceased to look upon aquatic birds as sure signs of the vicinity of land." He observes (1st Voy. vol. ii. p. 37), that shags and some other birds seldom fly out of sight of land, and adds that he believes gannets, boobies, men-of-war birds, seldom go far out to sea. Sir E. Belcher, however, met constantly with the gannet, frigate-bird, tropic bird, and booby, at considerable distances from the land, in the N. Pacific (Narrative of a Voyage round the World in H.M.S Sulphur, 1840). Cook considered divers a sign of land (1st Voy. vol. i. p. 47). Admiral Bellingshausen makes a similar remark† (Voyage of the Mirny and Vostok, vol. i. p. 215).

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* It is a mistake to suppose that merely filtering the water removes all noxious matters, as the process merely arrests, mechanically, solid particles. The Chinese purify water which has become offensive, by mixing half an ounce of alum to one ton, and leaving it for some time. Sir E. Home tried this with complete success in H.M.S. North Star (Naut. Mag. 1846, p. 625). This use of alum has long been known; powdered charcoal, and stirring clay in the water, have also been used.

† The stormy petrel (Mother Carey's chicken of sailors) is supposed to foretell wind; Bellingshausen remarks, on the contrary, that this bird made its appearance (at least near 4° N. and 20° W) before continued calms. Vol. i. p. 89.

Adm. Beechey remarks that black and white tern fly 40 miles from uninhabited islands, but desert altogether those that are inhabited.

1037. Dr. Scoresby observes that in the Arctic regions birds desert closing spaces in the ice, and repair to others which are opening.

1038 As a current of water, interrupted by the rising of a shoal or coast from the bottom of the sea, is carried upwards by the pressure from behind, and as the water below is, in warm and temperate climates, considerably colder than that on the surface, a fall in the temperature of the surface-water has often been found on approaching a shoal or the land, and the thermometer has accordingly been confidently recommended as a guide in coming into soundings. But it is evident that this effect must depend upon the relative coldness of the water above and below, and also upon the depth and other circumstances of the current, and it has been found that the indication is neither so constant, nor so marked, as to be depended upon. Capt. Foster, and more recently Capt. Fitz Roy found no such change on the Abrolhos. Sir E. Belcher (Voy. in H.M.S. Sulphur, 1840–1, vol. ii. p. 292) found no perceptible change on entering soundings off the Cape of Good Hope, or in the N. Pacific.

M. Du Petit Thouars (Voyage autour du Monde sur la Frégate La Vénus, 1836–9, vol. iii. p. 419) paid particular attention to this indication, and remarks that the observations generally shew a lowering of the thermometer on approaching land, but they disprove that the water on a bank is *always* colder.*

1039. The temperature of the sea has been observed to change several degrees, in intervals of time varying from a few hours to a day and a half previous to a change of wind, the water becoming gradually warmer when the wind was about to blow from a warm quarter, and colder in the contrary case. In squally weather the temperature has fluctuated.†

1040. The temperature of both the sea and the air is, however, so much influenced by the vicinity of ice in considerable mass, that the indications of the thermometer in such circumstances are highly important, more especially as fog, arising from the condensation of aqueous vapour by the cold, frequently occurs at the same time.

When the vessel is to leeward of the ice the air is greatly cooled; and, on the other hand, when the ice is to leeward and not far distant, the water through which it has drifted will be found colder than elsewhere.

1041. Amongst the signs of a near approach to land, on some occasions, are breakers. The depth of water at which they appear seems, however, very uncertain; and it is sometimes difficult to

* In the Gulf-stream, and on the banks of Newfoundland, the thermometer is said to be regular in its changes. (Purdy's Sailing Directions for the N. Atlantic.)

† Adm. Beechey records having made observations of this kind in the North Pacific, off C. Horn, and near Spitzbergen. (Beechey's Voyage to the Pacific, 8vo. vol. i. p. 325; Appendix, p. 390.)

distinguish between breakers and topping seas. The late Commander Mudge observed that a heavy swell often breaks in 9 or 10 fathoms, and always in 4 or 6; he adds that the swell is often heavier in a calm than in blowing weather. The sea is reported to break on the bar of the River Senegal in 8 fathoms.*

Mr. Thomas, master of H.M.S. Investigator, says that in the gale of August 1833, at the Shetlands, the sea broke over all rocks having less than 8 fathoms on them (Naut. Mag. 1835, p. 309).

1042. The only certain indication, in the absence of external signs, is the depth of water, when soundings can be obtained. Hence *sounding is an indispensable precaution*; and *neglecting to sound* has, in courts of inquiry and courts-martial, always been deemed *inexcusable*. *See* pp. 343, 344.

2. *Illusory Appearances.*

1043. While it is necessary to be on the alert for the discovery of danger, it is scarcely less so to be prepared against false alarms. For ex.: in a moonlight night, when blowing fresh, it is easy to fancy breakers and shoals, especially when on the look-out for them. Effects of light and shade have so much resembled breakers as to raise alarm; and sunbeams in the horizon, seen through rain, have been taken for rollers.—(Voyage of H.M.S. Sulphur.)

1044. Clouds and fog-banks often resemble land so much as to deceive an experienced eye. Sir Jas. C. Ross observes, that the vapour-line near the margin of ice in the polar regions is always taken for land by novices.

1045. Many reported islands or shoals, of which the accounts given have been apparently circumstantial, have, doubtless, been trees, fish, alive or dead, or ice islands. Phipps (Voyage to the North Pole in the Racehorse and Carcase, 1773, p. 57) took a small piece of ice covered with gravel for an island. Weddell (A Voyage towards the South Pole, 1822) records that it was only on passing 300 yards from an ice island that they ascertained it was not solid land, but ice covered with black earth. He also mentions having taken the swollen carcase of a dead whale for a rock,—a mistake of frequent occurrence. Sir Jas. Ross met with an iceberg which had turned over unperceived, and presented a new surface covered with earth and stones, so like an island, that nothing but landing on it convinced them to the contrary (vol. i. p. 195). Lieut. Wilkes records that a supposed rock turned out on examination to be a large tree covered with weeds and surrounded by fish (U.S. Expl. Exped.).

1046. Whales have probably, as Horsburgh remarks, been taken for rocks. These fish float at the surface for a long time together, and, being covered with barnacles, grass, or seaweed, exhibit an

* The sea is stated to have broken in 40 fathoms on the coast of Syria, in the gale of Dec. 1840 (Naut. Mag. 1841. p. 233)

appearance so like that of a rock that it is often difficult to believe the contrary.*

1047. The sound of breakers or surf has often been found to be caused by a shoal of fish. Kerguelen (Relation d'un Voyage dans la Mer du Nord, 1767-8, Paris, 1770, p. 121) saw a large shoal of small red fish that had the appearance of a sandbank, of the extent of two leagues, on which the sea was breaking, and the illusion was rendered the more complete by the great numbers of birds that accompanied it. Capt. Fitz Roy observes, that a shoal of fish seen under the water may have given rise to a report of a bank, which it much resembles. Weddell records having been alarmed in a fog by a cry of breakers, for which a noise produced by fish was taken. Most seamen's experience will supply similar instances.†

It has been remarked that it is very difficult at a distance to distinguish straggling ice and breakers from each other.

1048. A sound like that of guns is produced by the splitting of large masses of ice. Cook records an instance (1st Voyage, p. 47), and it is familiar to those who have been in the polar regions.

1049. The surface of the sea, in some parts of the world, is occasionally found streaked, for leagues together, by a matter which produces the "discoloured" aspect of shoal water, and which sailors suppose to be the spawn of fish. Water having this appearance is not approached without anxiety by those who are unaccustomed to it; and in those seas especially where coral reefs rise perpendicularly from very great depths, an increase of vigilance is demanded on such occasions.‡

1050. In these days, when the ocean is traversed by innumerable ships, appearances which were strange or alarming to the first navigators have become familiar; and the dangers which the enterprising men who first ventured upon an unknown sea were naturally disposed to multiply have disappeared from our charts. But in earlier times, when the solitary vessel had either no chart at all, or one put together from imperfect or incongruous materials, the feeble state of navigation justified the excess of caution in reporting as a danger every suspicious appearance.

Accounts, therefore, of new land or dangers, which are published from time to time, are not to be received without extreme caution, unless they state some circumstance which is decisive.

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* Sir F. Beaufort tells me, that in approaching the River Plate, in command of H.M.S. Woolwich, a whale was reported as a rock, and believed to be so by every one on board. But knowing that no rock existed in the situation, he steered direct for it, and when about 30 yards distant it dived. In H.M.S. Tyne, in the South Pacific, we bore up for what seemed to be the wreck of a ship floating, with her quarter raised out of the sea, but which, on approaching it, turned out to be a whale.

† To these or other circumstances, which have given rise to reports of shoals, may perhaps be added the shocks which have been experienced by ships striking against whales or other large fish.

‡ In the Alceste, while among imperfectly known parts of the Eastern Seas, we frequently passed through water thus tinged with some colouring matter. Mr. Darwin (Voyages of the Adventure and Beagle, vol. iii.) considers the effect to be produced by animalculæ.

3. *Dangers.*

1051. When the ship, going free, is found to be running into danger, the proper tack to haul to the wind upon is, generally speaking, that on which she will most rapidly increase her distance from it, because thus time will be gained.

1052. In high latitudes ice islands are often met with towards the close of the summer, or earlier. The presence of ice at night is often indicated by a peculiar effect of light, and in fog by a kind of blackness in the atmosphere (Scoresby's Arctic Regions, p. 255).

On falling in with ice the ship is recommended to pass to windward of it. It is observed that the smaller portions drift more quickly than larger ones, and that pieces of a round figure drift nearly before the wind, while angular pieces move irregularly.

Ice islands have been met with to the southward of the parallel of 50° N., in the Atlantic, and in the Southern Ocean in 36° S. The Captain of the *s.s. Forfarshire* reports that, in Jan. 1891 icebergs were met with in the following localities:—From lat. 51° 30′ S. to 49° 50′ S., and long. 46° 0′ W., sixty-three icebergs, half a mile to 3 miles long, and 200 to 300 feet high, were seen. Also an ice island, estimated to be over 30 miles in length and 300 to 400 feet high, was passed at the distance of about 5 miles.

From reports received there is reason to believe that icebergs may often be found in the positions given, and mariners are warned to give the localities a wide berth. See Admiralty Ice Chart, No. 1241; also Wind and Current Charts.

A remarkable diminution in the strength of the wind is experienced when to leeward of ice, even of very small extent. This is noticed by Sir E. Parry and by other navigators.

1053. There is also another source of danger, which appears to have increased of late years, and one less easily guarded against, in vessels which have been abandoned by their crews, in some cases unnecessarily, and which, having become more or less waterlogged, remain drifting about.

1054. To these may be added *rollers*, which term is applied to a very heavy swell rising on particular coasts, without any known cause, generally very quickly, and subsiding very soon, and which constitutes a formidable danger. H.M.S. *Julia* was wrecked in a calm at Tristan d'Acunha in a few minutes. More recently very severe loss was experienced at St. Helena. Rollers are noticed as a great danger on the coast of Guiana, where they break in 5 or 6 fathoms (Commander Darley in Naut. Mag. 1844, p. 649). The U. S. Expl. Expd. anchored off St. Francisco Nov. 1, 1841, the *Vincennes* being in 7 fathoms, and 3 miles off shore. About 10 P.M. the rollers got up and broke with the continued roar of a surf. At midnight a sea broke heavily on board the *Vincennes*, a ship of 780 tons, displaced the booms and boats, and killed a man. The other ships, in deeper water, felt no inconvenience.*

* Though great danger is incurred from breakers in shoal water, yet there are coasts on which the gradual shelving of the bottom dissipates the swell by degrees without causing a

4. *Determination of Position of Danger.*

1055. *Out of Sight of Land.*—When a rock, a shoal, or an island, is unexpectedly met with at sea, its bearing and estimated distance are to be noted, with the time by chronometer. As the true position can be determined by astronomical observation alone, the following directions are inserted for reference, the calculations being deferred to a convenient time.

(1.) When the *sun* is visible. Observe his altitude, noting the time by chronometer (see the note, No. 726). This gives the lat., Nos. 681, 696, or 718, or the time, No. 776, or 791, and thence the long. by chronometer.

(2.) When the *sun and moon* are visible. Observe both alts. with all possible care, and the lunar distance; the lat. is hence found, Nos. 681 or 692, 696 or 703, or 759, &c., and thence the time, and the long. by chron. or by lunar.

(3.) When the *moon* is visible. See Nos. 692, 703. In favourable cases the alt. gives the long., No. 864.

(4.) When the *moon and stars* are visible. Obtain the lunar distance, and both alts. with care. See, also, Nos. 864 and 866.

(5.) When the *stars* alone are visible. Observe altitudes near the meridian, and on opposite sides of the zenith, for lat.; and near the prime vertical for time and long. by chron.

Of the dangers to which navigation is exposed none is more formidable than a reef or a shoal in the open sea; not only from the almost certain fate of the ship and her crew that have the misfortune to strike upon it, but also from the anxiety with which the navigation of all vessels, within even a long distance, must be conducted, on account of the uncertainty to which their own reckonings are ever open. No commander of a vessel, therefore who might meet unexpectedly with any such danger, could be excused, except by urgent circumstances, from taking the necessary steps both for ascertaining its true position, and for giving a description as complete as a prudent regard to his own safety allowed.

1056. *In Sight of Land.* The position of a rock or a shoal may be determined by cross-bearings (No. 366) when the variation and deviation are known. It may be determined more accurately by taking the bearings of three objects, and using the angle between the bearings (No. 368). The sextant may be used, in preference to the compass, for convenience and accuracy; the face should be held horizontal, and the angles measured between points vertically under the objects, or determined by plumb-lines conceived to pass through the objects. No. 368.

[1.] *Report of New Discovery, or Correction of Position.*

1057. In transmitting an account of a new discovery, or the correction of a position, the first consideration is the lat. or long., or

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dangerous break. On the coast of Barbary, in H.M.S. Adventure, under the command of Capt. W. H. Smyth, we frequently, when the wind was dead on shore, ran to leeward out of the sea, till we found a convenient depth of water for anchoring.

the situation with respect to some other place. Attention should therefore be directed to the instructions at No. 835. It will, indeed, be evident on a moment's reflection, that the long. described merely, as is too often the case, as "long. by chron." without reference to some fixed point, is utterly valueless. Again, when such fixed point is mentioned, it is no less necessary to note the long. adopted: for ex.: "Long. by chron. from Callao," is little better than no allusion to place at all, as Callao appears in the tables in different longs. from 77° 10·5′ to 77° 15·7′.

When the determination depends on a lunar, notice should be taken, 1. of the skill of the observer; 2. of the instrument; and especially whether distances on opposite sides of the moon are observed; also, 3. of the probable error of the time.

1058. After the position the point next in importance is the *extent*, and general direction, if this can be assigned. Then follows height or depth, with notice of the appearance; and then anchorage, landing, supplies, and natives. The seaman will find these matters of detail passed in review, in the same constant order, in the symbolised descriptions in Table 10; and he may render much service by taking the opportunity of recording these particulars on passing any of the numerous places of which we have no very exact accounts.*

It will often be important to notice both the extent and appearance of islands, which have not been visited for a long time. Krusenstern, in alluding to the growth of many islands by submarine formations, which are continually extending themselves, as established by Fleurieu, Flinders, and Beechey, remarks that Capt. Carteret discovered a small flat island so nearly at the level of the sea, as scarcely to deserve the name of an island, which he called *Osnaburgh*. It was on this island that the Matilda was wrecked in 1792, as is proved by the agreement of her observations with those of Adm. Beechey, who found here the wreck of a ship. Thus the "small island" had, in 1827, an extent of 14 miles (Mém. Hydr. 1835, p. 94).

Again, in warm climates, reefs at the level of the sea are covered by degrees with a low vegetation, which, in due time, is succeeded by trees. Many places, therefore, now known merely as reefs, or not noticed at all, will probably become hereafter conspicuous islands.

1059. Whenever a position is noted, the bearings of headlands and islands should be observed as accurately as possible. The neglect of this is seriously felt in the arrangement of positions.†

Seamen may also supply very important elements for correcting

* If, in sending home such accounts, the writer uses symbols, he must be very careful to draw them in their perfect form, lest one may be taken for another. The great saving of time and space which they effect claims the necessary attention in writing them legibly.

† In the third and later editions of this work a discrepancy was admitted in the positions of Tanna, Annatom, and Erronan, from the want of bearings, though the places are in sight of each other. Capt. Denham, of H.M.S. Torch, removed the difficulty.

the charts by observing with care the bearing of two points of land when seen in a line, or *on with each other*, or of a summit seen over a point. Such bearings are called *transit bearings*.

1060. Views should accompany all hydrographic notices, when there is any one on board who can draw. On these should be marked one or more bearings (selecting, first, that of the nearest point), and the angles measured by a sextant between remarkable points or other objects; also the angular elevations of summits, as these last serve for the determination of heights.

It is also important, where the range is considerable, to note the time of tide, because the rise or fall of several feet in the water may cause a material change in the appearance of the shore, and has also the effect of altering the apparent dimensions of an island with shelving shores. Again, when the spectator is on shore, the place of the visible horizon varies with the height of the tide, being nearer to him and higher, when the water is higher (or when he is less elevated above it), and further off and lower, as the water falls (or as he increases his relative height). The consequence of this is, that an island beyond the visible horizon appears to the spectator on shore to be of different lengths at different times of the tide.

A small pamphlet entitled "Notes bearing on the Navigation of H.M. Ships," lately issued by the Admiralty, will be found to contain much practical and useful information.

EXPLANATION OF THE TABLES.

In this division of the work the use and application, and, in some degree, the construction, of the Tables, are described.

Rules are given for computing the terms in the Tables. These rules will be found useful for the purpose of verification; for the computation of an intermediate term instead of the ordinary interpolation; and also when the computer may require, for a particular object, to employ a table on a more extensive scale than would be convenient for the general purposes of the collection.

NAVIGATION *

THE SAILINGS.

These tables are used chiefly in the methods, Chapter III.

TABLE I.

This is called the TRAVERSE TABLE from its use in Traverse Sailing.

I. *Direct Application.*

Table 1 contains the Diff. Lat. and Dep. for the Course at every degree, and for each mile of distance to 600 miles, with the time corresponding to each degree.

When the Course is given in points, it should be turned into degrees (No. 216). If it is less than 4 points or 45°, the table is to be entered at the top; but from the bottom when it exceeds 4 points or 45°.

Ex. 1. Course $2\frac{1}{2}$ pts., Dist. 74 miles; find the D. Lat. and Dep.

In Table 1, at $28° = 2\frac{1}{2}$ points, and against 74 in the Dist. column, are D. Lat. 65·3, and Dep. 34·7.

Ex. 2. Course 68°, Dist. 241 miles; find the D. Lat. and Dep.

In Table 1, over 68° at the bottom, and against 241, are D. Lat. 90·3, and Dep. 223·5.

* The general division of the subject into Navigation and Nautical Astronomy naturally suggests the like division among the Tables. But, besides this, the computer cannot, in general, make proper use of the Astronomical Tables unless acquainted beforehand with his position on the globe. The Tables, therefore, relating to this last point, that is, those which are concerned in finding the position of the ship with reference to the place left, necessarily precede the others. The Table of Positions, which is usually found at the end of a collection of tables, is, according to this disposition, placed among those relating to Departures, since in actual navigation it is referred to only with reference to the place of the ship.

The author is indebted to many individuals whose opinions are entitled to every consideration for suggestions relative to the arrangement or order. It will, however, be obvious that no arrangement can be devised which shall be equally convenient for all persons at all times; and, perhaps, no plan is open to fewer objections of weight than one in which regard is paid both to the classification of subjects and to the successive stages of the computations.

In like manner, in taking out the Course corresponding to a given D. Lat. and Dep., when the D. Lat. is greater than the Dep., take the Course from the top; when less, from the bottom.

(1.) To take out the D. Lat. or Dep. to a fraction of a degree.

Ex. To find the Dep. to 11°¼ and Dist. 100.

The Dep. to 11° is 19·1, that to 12° is 20·8; ¼ of the difference 1·7, or ·4, added to 19·1 gives 19·5, the DEP. required.

In finding the D. Lat. this prop. part is subtractive.

(2.) To find the D. Lat. or Dep. for a fractional Dist., as, for example, for 59·3; find it for 59, and then for 3 (dividing the last by 10).

(3.) When the given Dist. exceeds 600 miles, divide it by 10, and multiply the D. Lat. and Dep. found by 10. So, likewise, when the given D. Lat. or Dep. exceeds the limits of the Table, divide it by 10, and multiply the resulting Dist. by 10.

Ex. 1. Course 31°, Dist. 1872 miles. The Course 31°, and Dist. 187, give D. Lat. 160·3, and Dep. 96·3; hence the required D. Lat. and Dep. are 1603 and 963 nearly.

Ex. 2. D. Lat. 660, and Dep. 165, to find the Course and Dist. D. Lat. 66, and Dep. 16·5, give Course 14°, and Dist. 68; the required Dist. is, therefore, 680 nearly.

This is near enough in general. For greater accuracy, in Example 1, take out the D. Lat. or Dep. for 600, and for the excess above 600.

2. *Trigonometrical Quantities.*

If the angle A C B, fig., No. 162, be considered the Course, and A C the Distance, then A B becomes the Dep. and C B the D. Lat.

Hence, by No. 162, the *Dep.* corresponding to the *Dist.* 100 is the *sine* for the radius 100.

The *D. Lat.* to the *Dist.* 100 is the *cosine* for the radius 100.

In like manner, the *Dep.* to the *D. Lat.* 100 is the *tangent* for the radius 100.

The *Dist.* to the *D. Lat.* 100 is the *secant* to the radius 100.

Thus also the *D. Lat.* to the *Dep.* 100 is the *cotangent;* and the *Dist.* to the *Dep.* 100 is the *cosecant* to the same radius 100.

The trigonometrical quantities (which are calculated for radius 1) are deduced from the numbers thus found in the Traverse Table by marking off two decimals.

Ex. 1. Find the Sine of 27°. At the arc 27°, the Dist. 100 gives the Dep. 45·4. The SINE is, therefore, ·454, the log. of which is 9·657 (Nos. 58 (2) and 59, p. 19). This is the log. given in Table 68.

Ex. 2. Find the Cosine of 56°. At 56°, the D. Lat. to the Dist. 100 is 55·9, the COSINE is ·559, the log. of which is 9·747.

Ex. 3. Find the Tangent of 38°. At 38°, the D. Lat. 100 corresponds to Dep. 78·2, the TANGENT is ·782, the log. of which is 9·893.

Ex. 4. Find the Secant of 42°. At 42°, the D. Lat. 100 corresponds to the Dist. 134·6, the SECANT is 1·346, the log. of which is 0·129, or in Table 68, 10·129 (No. 166, *Note*).

Ex. 5. Find the Cotangent of 54°. At 54°, the Dep. 100 corresponds to D. Lat. 72·7 the COTANG. is ·727, the log. of which is 9·861.

Ex. 6. Find the Cosec. of 18°. At 18°, the Dep. 100 corresponds to Dist. 323·4, the COSEC. is 3·234, the log. of which is 0·510.

[1.] *Solution of Right-Angled Triangles.*

These tables are useful in solving approximately cases of right-angled triangles, as also in roughly verifying the results of questions of the kind when obtained by logarithms.

Ex. p. 48. Angle A 50°, CA 28 feet, find AB and BC.
At 50°, the Dist. 28 gives the D. Lat. 18, which is AB, and the Dep. 21·4, or CB.

Ex. p. 49, Case II. Angle A 30°, BC 171; find AB and AC.
Course 30° and Dep. 85·5 give Dist. 171, or BC 342, and D. Lat. 148·1, or AC 296·2.

Ex. p. 49, Case III. AB 220 3, AC 101·9; find the Angle B and BC.
Dist. 220 and Dep. 103·3 are the nearest, and give 28° for the Angle B, and the D. Lat or BC 194.

8. *Proportional Quantities.*

Mr. A. C. Johnson, R.N., in his valuable pamphlet on "Finding Latitude and Longitude in Cloudy Weather," * has shown how Table I. may be used to correct the Longitude for error in Latitude.

With the complement of the object's bearing at sights as a course, and error in Latitude as a Diff. Lat., take out Dep. This converted into Diff. Long. will be the correction required.

East: When the true latitude is South of the approximate, and azimuth of object between N. and E., or between S. and W.
Or when the true latitude is North of the approximate, and azimuth of object between S. and E., or between N. and W.

West: When the true latitude is South of the approximate, and azimuth of object between S. and E., or between N. and W.
Or when the true latitude is North of the approximate, and azimuth of object between N. and E., or between S. and W.

Ex. In Lat. 45° S., sun bearing S. 55° W., ship by observation was in long. 3°·45 W., but the error in lat. was found to be 18 m. South.
Complement of Azimuth 35°. Then Course 35° and Diff. Lat. 18′ give Dep. 12′·6. Dep. 12′·6 and Lat. 45° give Diff. Long. 18′. True lat. South of approximate, and azimuth between S. and correction is E.

Long. from Observation	3° 45′ W.
Correction	18 E.
True Long...	3 27 W.

* Published by J. D. Potter, Agent for Admiralty Charts, 145 Minories.

[To face p. 378.

(1.) To turn *statute miles* into nautical or *geographical miles.*

1 statute mile = 0·8684 geogr. 1 geogr. mile = 1·1515 statute miles.
At 61°, the Dist. and Dep. correspond to *statute* and *geogr.* miles.

(2.) To turn *feet per second* into *nautical miles per hour.*

At 36°, the Dist. and Dep. correspond to *feet* and *miles*; thus the rate of 19 feet per second is 11 miles an hour, nearly.

The measures and soundings on foreign charts are reduced, in like manner, to our own scales.

(1.) To turn *Danish Favne* into *English Fathoms*.

1 fav. = 1·0292 fath. 1 fath. = 0·9716 fav.

At 76°, the Dist. and Dep. correspond to *fathoms* and *favne*; thus, 100 favne are 103 fath. nearly.

(2.) To turn *Danish Feet* into *English Feet*.

1 Dan. foot (*fod*) = 1·0270 Eng. feet. 1 Eng. foot = 0·9737 Dan ft

At 77°, the Dist. and Dep. correspond to *English* and *Danish feet*; thus, 200 Danish feet are 205 English feet nearly.

(3.) To turn *Dutch* (Amsterdam) *Feet* into *English Feet*.

1 Amst. foot = 0·9287 Eng. ft. 1 Eng. foot = 1·077 Amst. ft.

At 68°, the Dist. and Dep. correspond to *Dutch* and *English feet*. Thus, 300 Dutch feet are 278·2 English feet nearly.

(4.) To turn *Dutch Palms* into *English Feet*.

1 palm = 0·3283 ft. 1 foot = 3·046 palms.

At 19°, Dist. and Dep. correspond to *palms* and *feet*. Thus, 100 palms are 32·6, or more nearly, 32·8 feet.

(5.) To turn *French Brasses* into *English Fathoms*.

1 brasse = 0·888 fath. 1 fath. = 1·126 brasse.

At 62°, the Dist. and Dep. correspond to *brasses* and *fathoms*. Add 1 in 180. Thus 200 brasses are 176·6, or more nearly 177·6 fathoms.

(6.) To turn *French Metres* into *English Yards*.*

1 metre = 1·0936 yard. 1 yard = 0·9144 metre.

At 66°, the Dist. and Dep. correspond to *yards* and *metres*. Thus, 300 yards are 274·1 metres nearly.

(7.) To turn *French Feet* (*Pieds*) into *English Feet*.

1 pied = 1·0658 ft. 1 foot = 0·9383 pied.

At 70°, the Dist. and Dep. correspond to *pieds* and *feet*. Thus, 200 pieds are 213 feet nearly.

(8.) To turn *French Toises* into *English Fathoms*.

1 toise = 1·0658 fath. 1 fath. = 0·9383 toise.

At 70°, the Dist. and Dep. correspond to *toises* and *fathoms*. Thus, 200 toises are 213 fathoms nearly.

(9.) For the *Prussian Foot* (*Fuss*), see *Danish*.

(10.) To turn *Russian Arsheens* into *English Feet*.

1 arsh. = 2·3343 ft. 1 foot = 0·4284 arsh.

At 25°, the Dist. and Dep. correspond to *feet* and *arsheens*. Deduct 1 in 60. Thus 86 arsheens are 203 feet, or more nearly 200 feet.

(11.) To turn *Russian Sashes* (*Sazhens*) into *English Fathoms*.

1 sazh. = 1·1671 fath. 1 fath. = 0·8568 sazh.

At 59°, the Dist. and Dep. correspond to *fathoms* and *sashes*. Thus, 300 fathoms are 257·1 sazhens. Thus, the *arsh.* = 28 in.; the *sazheu* = 7 f., and the *verst* (12) = 500 *sazheus*.

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* The following French measures occur frequently :—

1 Myriametre	= 10,000 metres.	Metre		= 39·37079 Eng. in
1 Kilometre	= 1000	Decimetre	= 1-10th met.	= 3·937079
1 Hectometre	= 100	Centimetre	= 1-100th met.	= 0·393708
1 Decametre	= 10	Millimetre	= 1-1000th met.	= 0·039371

To turn *Russian Versts* into *Nautical Miles.*

1 verst = 0·5759 mile. 1 mile = 1·7364 verst.

At 35°, the Dist. and Dep. correspond to *versts* and *miles*. Add 1 in 260. Thus, 300 versts are 172·1, or more nearly (adding ·6) 172·7 miles.

(13.) To turn *Spanish Brazas* into *English Fathoms.*

1 braza = 0·915 fath. 1 fath. = 1·092 braz.

At 66°, the Dist. and Dep. correspond to *brazas* and *fathoms*. Thus, 200 brazas are 183 fathoms nearly.

(14.) To turn *Spanish Varas* into *Yards*

1 vara = 0·9142 yard. 1 yard = 1·0964 var.

At 66°, the Dist. and Dep. correspond to *varas* and *yards*. Thus, 300 varas are 274·3 yards.

(15.) To turn *Swedish Feet* into *English Feet.*

1 Swed. foot (*fod*) = 0·9739 Eng. foot. 1 Eng. foot = 1·0268 Swed. foot.

At 77°, the Dist. and Dep. correspond to *Swedish* and *English feet*. Thus, 300 Swedish feet are 292·3 English feet.

To compute a Term. For the D. Lat. To the log. of the Dist. add the log cos. of the Course; the sum is the log. of the D. Lat

For the Dep. To the log. of the Dist. add the log. sine of the Course; the sum is the log. of the Dep.

TABLE 3. DEPARTURE AND CORRESPONDING DIFFERENCE OF LONGITUDE

This Table shews the number of minutes of Longitude in any number of nautical miles from 1 to 10, measured E. and W., in lats. under 70°.

Ex. 1. Lat. 49°, Dep. 27m.; find the D. Long.

49°,	20 (2 × 10)	30·48
	7	10·67
	D. LONG.	41·15

Ex. 2. Lat. 31° 30′, Dep. 8·7m.; find the D. Long.

31½°,	8	9·38
	0·7	0·82
	D. LONG.	10·20

In general, interpolation for any fraction of a degree may be effected nearly enough at sight, as in Ex. 2; but when accuracy is required, find the D. Long. for the two whole degrees, including the fractional lat., take the diff. of the two results, and with it enter the col. headed D to 1°, take out the parts and *add* them.

Ex. 2, above.

31°, 8	....	9·33	9·33
32,		9·43	
	D. to 1°	0·10, for 30′,	+ ·05
			9·38
31½, 0·7			+ ·82
		D. LONG.	10·20

The Table may often be useful in parallel and mid. lat. sailing; though, to be properly adapted to this purpose, it should be greatly extended. Its chief utility lies in the reduction or comparison of longitudes in plans not graduated.

To compute a term. To the log. of the Dep. add the log sec of the Lat.; the sum (rejecting 10) is the log. of the D. Long.

TABLE 4. DIFFERENCE OF LONGITUDE AND CORRESPONDING DEPARTURE

This Table shews the number of nautical miles in any number of minutes of longitude from 1 to 10, in lats under 70°

Ex. I. Lat. 64°, D. Long. 272′; find the Dep.

64°,	200	88·0
	70	30·7
	2	0·9
	Dep.	119·6

Ex. 2. Lat. 22°½, D. Long. 4′·6; find the Dep

22°, 4	3·71	.... 3·71
23,	3·68	
	D. to 1° 0·03, for 30′...	− ·02
		3·69
22½ 0·6	....	+ ·56
	Dep.	4·25

The remarks on Table 3 apply to Table 4, except that the parts for the fraction of a degree are to be *subtracted*.

To compute a term To the log. of the D. Long. add the log cos of the Lat.; the sum (rejecting 10) is the log. of the Dep

Table 5. Spherical Traverse Table

This Table is named from its being used with the common or plane Traverse Table, in cases which involve Spherical Trigonometry.

The Table is entered with the *lesser* of two given arcs or angles at the top, and the other at the side; thus, to take out M and N for 64° and 15°, enter with 15° at the top and 64° at the side, then M is found 236·2, and N 54·9 *

Interpolation for a fraction of a degree is easy, because M and N always increase. In general, it is enough to take M or N at sight, as directed No. 19; thus, for ex., to find M for 59° 47′ and 66° 18′, that is, for 59¾ and 66⅓, we may take 496.

For greater precision, take the differences between each two terms concerned, and proceed to proportion separately for each.

The Table solves by inspection, approximately only, but very expeditiously, several problems. This method, besides being near enough for many practical purposes, will often be useful as a check against mistakes in longer methods.

(I.) To find the Hour-angle from the alt. No. 613.

With the lat. and decl. find M and N. With the alt. as Course, and M as Dist. find the Dep.

When the lat. and decl. are of *contrary* names, take the *sum* of the Dep. and N. The course answering to this sum as D. Lat. and Dist. 100 is the Hour-angle required.

When the lat. and decl. are of the *same* name, take the *diff.* of the Dep. and N. When the Dep. *exceeds* N, the course answering to this Diff. as D. Lat. and Dist. 100 is the Hour-angle; but when the Dep. is *less* than N, the supplement of the said course is the Hour-angle.

Ex. 1. Lat. 15° 32′ N., decl. 8° 35′ S., alt. 15° 26′: required the Hour-angle.

15°½ and 8°½,	M 104·9, N	4·1
15°½ (alt.) and 105,	Dep.	28·0
	(*sum*)	32·1

Hour-angle, $4^h\ 44^m$.

Ex. 2. Lat. 51° 10 S., decl. 19° 27′ N. alt. 11° 51′: required the Hour-angle.

19°½ and 51°,	M 168·6, N	44·7
11°¾ and 169,	Dep.	34·4
	(*sum*)	79·1

Hour-angle, $2^h\ 31^m$.

* It will be perceived, on inspecting the examples, that after M and N are taken out to the given arcs, the arithmetical process is very similar in all the problems; very little practice will, therefore, render the several uses of the Table familiar. As the process of computation consists in the addition or subtraction of two numbers only, thus taken out by Inspection, it will be difficult, if not impossible, to find general solutions more concise. As M is always greater than N, they can never be confounded together.

It is because the Dep. always *increases* with the course, that it is used in preference to the D Lat. in the solutions by this Table, the rules being adapted accordingly

Ex. 3. Lat. 56° 50′ S., decl. 56° 10′ S., alt. 64° 47′: required the Hour-angle.

57° and 56°, M 328·3. N 228·3
65° and 328, Dep. 297·3
(*diff.*) 69 0

Hour angle, 3^h 5^m (since the Dep. *exceeds* N).

Ex 4. Lat. 47° 3′ N., decl. 22° 37′ N. alt. 8° 20′: required the Hour-angle.

47° and 22°½, M 158·7, N 44·4
8°⅓ and 159. Dep 23·0
(*diff.*) 21·4

Course, 5^h 11^m; or Hour-angle, $6^h 49^m$ (since the Dep. is *less* than N).

When the lat. or the decl is 0, N is 0, and the Dep. is to be taken as the D. Lat. to 100; the Course corresponding is the Hour-angle required.

Ex. 5. Lat. 0°, decl. 14° N. or S., alt. 27°: required the Hour-angle.

0 and 14°, M 103·1
27° and 103, Dep. 46·8
Hour-angle, 4^h 8^m.

Ex. 6. Lat. 38° N. or S., decl. 0°, alt. 27°: required the Hour-angle.

0° and 38°, M 126·9
27° and 127, Dep. 57·7
Hour-angle, 3^h 40^m.

(2.) To find the Hour-angle on the Prime Vertical, No. 618.

With the decl. and colat. find N; with 100 as Dist. and N as D Lat find the Course.

Ex. Lat. 31°, decl. 14°. 14° and 59° give N. 41·5; 100 Dist. and 41·5 D. Lat. give Hour-angle 4^h 22^m.

(3.) To find the Hour-angle at rising and setting, No 620.

With the lat. and decl. take out N. With the Dist. 100 and N as D. Lat. find the Course.

When the lat. and decl. are of *contrary* names, this is the Hour-angle required; when of the *same* name, take the *suppl.* to 12 hours.

Ex. 1. Lat. 51° N., decl. 27° N.: find the Hour-angle at rising or setting.

27° and 51° give N 62·9

Dist. 100 and D. Lat. 62·9 give Course $3^h 24^m$, and the Hour-angle required $8^h 36^m$.

Ex. 2. Lat. 31° N., decl. 40° S.: find the Hour-angle at rising or setting.

31° and 40° give N 50·4

100 and 50·4 give 4^h, the Hour-angle required.

(4.) To find the effect of Refraction, &c. on the above, No. 638.

With the lat. and decl. take out M. With M as Dep. and the Hour-angle at rising or setting as Course, take out the Dist. Multiply this Dist. by the sum of 34′ and the depression to the height, Table 8; the product divided by 1500 is the portion of time required in min. and decimals.

Ex. 1, No. 638. Lat. 28° and Decl. 16° give M 117·8. Then Lat. 28° N. and Decl. 16° N. give Hour-angle at setting, 6^h 35^m. The suppl. of this, as it exceeds 6^h, or 5^h 25^m as Course, and Dep. 117·8, give Dist. 119.

Dist. 119 mult. by 34 + 117, or 151, is 17969; which, ÷ by 1500, gives $11^m{\cdot}9$.

(5.) To find the Time of Twilight, No. 641.

With the lat. and the sun's decl. find M and N. With the Course 18° and the Dist. M find the departure.

When the lat. and decl. are of *same* name, *add* this dep. to N; the Course corresponding to the sum as D. Lat. and Dist. 100 is the A. T. of the beginning of twilight, A.M.

When the lat. and decl. are of *contrary* names, take the diff. between the above Dep. and N; the Course corresponding to this diff. as D. Lat. and Dist. 100 is the time twilight *begins*, A.M., when the Dep. is *greater* than N; and the time it *ends*, P.M., when the Dep. is *less* than N.

Each of these times is the supplement of the other to 12^h.

Ex. Lat. 30° N., sun's decl. 20° N.: required Beginning and End of Twilight.

20° and 30° give M 122·9 and N 21. Course 18° and Dist. 123 give Dep. 38 (greater, *same* name) *sum* 59. Dist. 100 and D. Lat. 59 give Course $3^h\ 56^m$, the time it Begins A.M.; hence it Ends at $8^h\ 24^m$ P.M.

(6.) To find the altitude on the Prime Vertical, No. 664.

With 0 and the colat. find M. With the decl. as Course and M as Dist. find the Dep. With Dist. 100 and this Dep. find the Course.

Ex. Lat. 52°, Decl. 22°. 0 and 38° give M 126·9, 22° and Dist. 127 give Dep. 47·6, Dist. 100 and 47·6 give Course or Alt. 28°½.

Ex. 3, No. 665 (worked to the *nearest degree*), gives Dep. 100, equal to the Dist. which means that the Alt. is 90°, or it is an extreme case.

(7.) To find the Altitude, the Hour-angle being given, No. 666.

With the lat. and decl. take out M and N. With the compl. of the hour-angle to 6^h as a Course, and Dist. 100, find the Dep.

When the lat. and decl. are of *contrary* names, take the *diff.* of this Dep. and N. When the lat. and decl. are of the *same* name; if the hour-angle is *less* than 6^h, take the *sum* of the Dep. and N; if *greater* than 6^h, take the *diff.*

With this sum, or diff., as Dep. and M as Dist. find the Course, which is the alt. required.

Ex. 1. Lat. 15° 32′ N., decl. 8° 35′ S., Hour-angle, $4^h\ 45^m$: required the Alt.

8°½ and 15°½, M 104·9, N 4·1
$1^h\ 15^m$ and Dist. 100 Dep. 32·2
(*cont.* name), *diff.* 28·1

Dist. 105 and Dep. 28·1 give Co. 15°½ the Alt.

Ex. 2. Lat. 47° 3′ N., decl. 22° 37′ N., Hour-angle, $6^h\ 50^m$.

22°½ and 47°, M 158·7, N 44·4
$0^h\ 50^m$ and 100 Dep. 21·6
(*diff.*) 22·8

159 and Dep. 22·8 give Alt. 8°.

Ex. 3. Lat. 56° 50′ N., decl. 56° 10′ N., Hour-angle, $3^h\ 5^m$.

56° and 57°, M 328·3, N 228·3
$2^h\ 55^m$ and 100. Dep. 69·0
(*sum*) 297·3

164·1 and 148·6 give Alt. 65°.

Ex. 4. Lat. 22° S., decl. 3° N., Hour-angle, $2^h\ 15^m$.

3° and 22°, M 108·0, N 2·1
$3^h\ 45^m$ 82·9
(*diff.*) 80·8

Alt. 49°.

When the lat. or decl. is 0, N is 0, and the Dep. taken as Dep., with M as Dist. gives the course. When both lat. and decl. are 0, the alt. is the compl. of the hour-angle in arc.

(8.) To find the Azimuth, the Altitude being given, No. 673.

With the lat. and alt. take out M and N. With the decl. as course, and M as Dist., find the Dep.

When the lat. and decl. are of *contrary* names, take the *sum* of this Dep. and N; when of the *same* name, their *difference*.

With the dist. 100, and this sum or diff. as D. Lat., find the course, which is the azimuth required.

When the lat. and decl. are of *contrary* names, this azimuth is to be reckoned from the S. in N. lat. and from the N. in S. lat. When they are of the *same* name,—when the Dep. is *less* than N, reckon the azimuth from the S. in N. lat., and from the N. in S. lat.; when the dep. is *greater* than N, reckon the azimuth from the elevated pole, or from the N. in N. lat.

The azimuth is reckoned E. or W. as the celestial body is to the E. or W of the merid. at the time proposed.

Ex. 1. Lat. 10° S., alt. 58° 40′ to E-d., decl. 14° 24′ N. (*contrary* names).

10° and 58° ¾	M 195·8	N 29·0
14° ½ and 196		Dep. 49·0
		(*sum*) 78·0

100 and D. Lat. 78·0 give 39°¼, the Azim. req., which (in S. lat.) is N. 39°¼ E.

Ex. 2. Lat. 51° 30′ N., alt. of Arcturus 40° 25′ to W-d., decl. 20° 2′ N. (*same* name).

51° ½ and 40 ½	M 211·2	N 107·3
20° and 211		Dep. 72·2
		(*diff.*) 35·1

100 and D. Lat. 35·1 give 69°½, or Azim. req., S. 69 ½ W., as the Dep. is the *lesser*

When the Lat. is 0, N is 0, and the Dep. itself becomes the D. Lat., which, with Dist. 100, gives the Course.

When the Declin. is 0, the Dep. is 0, and N becomes the D. Lat., which, with Dist. 100, gives the Course.

Ex. 3. Lat. 0, declin. 21° N., alt. 61°.

Lat. 0 and 61	M 206·3	N 0
21 and 206·3	Dep. 73·8	

100 and D. Lat. 73·8 give 42°½, the Azimuth.

Ex. 4. Lat. 48° S., decl. 0, alt. 34°.

48° and 34°	M 180·3	N 74·9
0 and 180·3		Dep. 0

100 and 74·9 give Course 41°¾, the Azimuth.

*To compute M and N.** For M, add together the log. secants of the given arcs, add 2 to the index, and reject the tens; the sum is the log. of M. For N, add together the log. tangents, and proceed as for M.

Ex. Find M and N for 15° 40′ and 69° 11′.

15° 40′		log. sec. 0·01644		log. tan. 9·44787
69 11		log. sec. 0·44931		log. tan. 0·41999
	M 292·2	log. 2·46575	N 73·8	log. 1·86786

Table 6. Meridional Parts.

These are the number of minutes corresponding to each degree and minute of lat. on Mercator's chart. For ex., the mer. parts to lat. 39° 12′ are 2560.†

The mer. parts are given to each minute of latitude as far as 78°.

To compute a Term. Add 45° to half the latitude, and take out the log. tan. of this sum (rejecting 10), take away the decimal mark.

The process may now be completed *arithmetically*, thus:—Complete this number to 7 figures by annexing ciphers, or, if the index is 11, to 8 figures, and multiply by 0·00079157.

But it is more convenient to use logs. Consider the log. tan. thus prepared, as a natural number, and take out its logarithm. When the lat. is less than 13° 6′ prefix the index 5, when between 13° 6′ and 78° 34′ 44″ prefix 6, and when above this last, 7. Add the const. log. 6·898489; the sum is the log. of the mer. parts.

* By the plane Traverse Table. With the greater arc as a course, and D. Lat. 100, take out the Dist. and Dep. With the other arc as course, and the said Dist. as D. Lat., take out the Dist.; this is M. With the said Dep. as D. Lat. take out the Dep.; this is N.

When the D. Lat. 100 is not found exactly, take out the Dist. and Dep. for the next less, and add the Dist. due to the defect from 100.

Ex. Find M and N to 20 and 42°. The Course 42° and D. Lat. 100 give Dist. 134·6, and Dep. 90·0. Then 20 and D. Lat. 134·6, give the Dist. or M 143·2, and the D. Lat. 90 gives Dep. or N 32·8

All the methods by Inspection may thus be effected by the plane Traverse Table.

† The nearest unit is, of course, enough in navigation. In the construction of charts two decimals may be necessary, and recourse may be had to Dr Inman's, or Mendoza Rios's Tables.

Ex. 1. Find the Mer Pts. for the Lat. 3° 19′.

2) 3° 19			
1 39½	46° 39′½	log. tan.	10·025154
45			

Arithmetically. Annexing 2 ciphers gives 2515400, which multiply by 0·00079157 = 199·112.

By logs. 2515	log.	·400538
4		70
Index 5,		5·400608
	Const.	6·898489
Mer. Pts. 199·11	log.	2·299097

Ex. 2. Find the Mer. Parts for Lat. 58° 50′

2) 58° 50			
29 25	74° 25		
45		log. tan.	10·554565
5545		log.	·743902
6			47
5			4
Index 6,			6·743953
		Const.	6·898489
Mer. Pts. 4389·77		log.	3·642442

Ex. 3. Find the Mer. Parts for the Lat 78° 36′.

The log. tan. is 11·000812, the index prefixed 7, Mer. Parts 7922·13.

The 6th figure in using tables to 6 places, will often be in error nearly 1; hence the mer. parts may be in error nearly ·01, or 1-100th of a mile, or nearly 60 ft.

Note.—If the Spheroidal Mer. Pts. are required, enter the Traverse table with the lat. as a Course and 21 4 as a Dist.: the Dep. will be the reduction required. Ex. lat. 51° has Mer. Pts. 3569: Course 51° and Dist. 21·4 has Dep. 17: then 3569 − 17 = 3552, Spheroidal Mer. Pts. for 51°.

DEPARTURES.

These Tables are used in the methods, chap. iv. p. 137.

Table 7. For finding the Distance of an Object by two Bearings and the Distance run between them.

The use of this Table is described in No. 350.

To compute a Term. To the log. sine of the difference between the course and the 1st bearing, add the log. cosec. of the diff. between the difference of the course and the 1st bearing and that of the course and the 2d bearing; the sum (rejecting tens) is the log. of the term.

Table 8. True Depression of the Sea-Horizon.

This Table contains the Depression to each minute as far as 240, with its square, and the corresponding height in feet.

The Depression is the Distance of the visible horizon, No. 205.

The Table may be also useful for reference, as containing the squares and square roots of several numbers.

To compute a Term. Multiply the square root of the height in feet by 1·063. Or, for greater precision, to the const. log. 6·49034, add half the log. of the height in feet; the sum is the log. tangent (or log. sine nearly enough) of the depression.*

Approximately, the dist. visible in miles is the square root of the height in feet, an accidental relation easy to remember.

* As the lower latitudes are more frequented by shipping than the higher, 40° has been assumed as the average latitude. Also, as the curvature of the earth is different on the prime vertical and on the meridian, the circle of curvature, crossing the meridian at 45° of azimuth, has been employed. The depression is accordingly computed to the radius 20,909.577 feet which gives the length of the average nautical mile 6082 feet nearly. See Table 64A.

Ex. Find the True Depression for the height 107 feet.

By Table 8 the square root of 107 is seen to be $10\frac{1}{3}$, or 10·3 nearly.

Then 10·3 × 1·063 = 10·9 the Tr. Depr.

Square root of	$\frac{2}{20909577}$	= Const.	6·4903
Log. of 107,	2·0294.,		1·0147
Tr. Depr.	11′ 0′	sin.	7·5050

Table 9. Number of Feet subtending an Angle of 1′.

This Table gives, by simple proportion, the number of feet subtending an angle of any number of minutes and seconds within 3° or 4°, for any distance in nautical miles. It is very convenient for finding approximately the distance in miles of an object of given dimensions, as also the dimensions of an object seen under a given angle at a given distance.

The simplest way of using the Table is to find from the question the number of feet subtending 1′.

Ex. 1. The angular height of a mast-head, 138 feet high above the water-line of the vessel, and no horizon intervening, is 9′: required the Distance of the Vessel.

138 ÷ 9 gives 15·3 feet, which subtends 1′ at nearly 9 miles, the Dist. required.

Ex. 2. The distance between two vertical lights is 60 feet, and the angle it subtends is 4: required the Distance of the Light-house.

60 ÷ 4 gives 15 feet for 1′, and Dist. required $8\frac{1}{2}$ miles.

Ex. 3. The length of a vessel from the stern to the jib-boom end is 198 feet, and she subtends (when seen exactly, or nearly, broadside on), 27′: required her Distance.

198 ÷ 27 gives 7·3 feet to 1′, and Dist. required 4 miles.

Ex. 4. A cliff distant $5\frac{1}{2}$ miles subtends a vertical angle of 39′ (above the water or surf line): required its Height.

At $5\frac{1}{2}$ miles 9·72 feet subtend 1′, and 39 × 9·72, 379 feet, the Height required.

The number of feet in the Table corresponds nearly to the number of miles increased by $\frac{3}{4}$ of itself; thus, 8 miles gives 14 feet.

To compute a Term. To the log of the dist. in feet add 30103 (the log. of 2) and the log. tan. of half the angle proposed (here 1′): the sum is the log. of the term required.

Table 10. Maritime Positions.

Order of Places. The places follow each other in their order along the coasts, except where it is convenient to pass to an island or shoal adjoining, after which the coast is again continued.

The Alphabetical Index at p. 540 removes the difficulty which would otherwise be experienced in searching for a particular place under any arrangement whatever of islands irregularly placed in the ocean.

Names in the Side Columns. The names of countries and seas inserted at the side of each column are intended merely to assist the forming of a general idea of the contents of the page, and are not to be considered as accurately defining geographical or political divisions.

Mountains. Mountains visible from the sea are inserted, as convenient for taking departures, and for the examination of the compass. The heights of summits (to the tops of trees) are given in feet; when the height is considerable, and not accurately known, the distance in *leagues*, at which it is visible, is given instead of the height. The height may on many occasions be the means of identifying the land.* When the height precedes the point of which the position is given, it applies to the summit of the island or cape.

Lights. The descriptions of lighthouses are in most cases given. In the case of two lights, the height, and also the position, relate to the highest. See also pp. 402, 403.

Heights. All the heights taken from the latest Admiralty charts are reckoned from *high water*, in order to throw the error due to a difference in the height of the tide on the safe side. For ex., a light 120 feet above high water, seen at a certain (angular) altitude, places the ship 2 miles off. Now, at any other time of tide, the height exceeds 120 feet, and, in order to view it under the same angle, the ship must be more than 2 miles off; that is, the ship is really further off than is supposed, which is as it should be.

Secondary Meridians. These are the places in small capitals. See p. 392.

Latitudes and Longitudes. The Latitudes of ports are given to the nearest tenth of 1′; that is, to 6″. The error due to this manner of notation cannot exceed 3″, which is a quantity not worth dispute, except in fixed observatories.

The Longitudes of ports are given to those tenths only of 1′ which correspond to the nearest *second of time*. These are ·25, ·5, and ·75; the ·05 being dropped, ·2 stands for 1^s (or 15″), ·5 for 2^s (or 30″), and ·7 for 3^s (or 45″); that is, the seconds of time are, in round numbers, *half* the number of tenths: thus, 27′·2 is read 27′ 15″, or $1^m\ 48^s$ and 1^s, or $1^m\ 49^s$. The 2 and 7 used thus are distinguished by a dot below. By this slight change in the notation, we are enabled to employ at once the diff. long as deduced by the Traverse Table in minutes of arcs and tenths, while we preserve the utmost precision that can ever be required in practice.†

As 1′ of long is 4^s of time, the error of neglecting the seconds in the longitude cannot exceed 2^s.

The omission of the tenths in the longitude, when those of the latitude are given, implies that such longitude is not well determined. The *tenths* of 1′ noted in several longitudes do not, however, always imply precisely this degree of accuracy in the position, but serve to indicate stations to which the longitudes of places, not very distant, may conveniently be referred.

The positions of headlands, which are generally passed at the distance of some leagues, are given to the nearest minute only, in order to relieve the

* It does not consist with the design of this volume to give rules for determining the height of the land from the observation of its altitude with a sextant. But when the distance of the ship from the land is known, it will always be easy, by observing the altitude and *assuming* a height, to find whether the assumed height agrees or not with the known distance, by means of the rules in chap. iv. p. 139, and thus by a trial or two the true height will be obtained nearly. As the height of the land is a very important element in navigation and maritime geography, seamen may render essential service by taking advantage of favourable opportunities of determining heights in this way.

† Admiral W. F. W. Owen has employed this method of notation in his Table of latitudes and longitudes, as more convenient, in actual navigation, than that of seconds

computation from useless details. When the position falls on a half min. it is marked ½ a min. to *seaward*, to throw the error on the safe side.

The position relates to the last-mentioned point (not in parentheses).

Groups of Islands. All groups of islands, and all single islands, rocks or shoals, recorded, are inserted. In many groups all the islands are noticed; where this is not necessary, those marking the limits are given.

Submarine Volcanoes. Between the lats. 7° N. 1° S., and long. 16° and 24° W., several ships have met with ashes or experienced shocks. Krusenstern, on May 9th, 1806, saw, in 2° 43′ S., 20° 33′ W., a column of smoke, which shot up at intervals. There is little doubt, therefore, that the region is volcanic; and though Capt. Wickham, in H.M.S. *Beagle*, found no bottom at 190 fathoms in 1° 55′ S., 23° W., it is not unlikely that a shoal may at some time appear, and on this account the attention of seamen is directed to this region in column (41).

It may be remarked here, that land suddenly thrown up has quickly sunk again.

Orthography. In the names of places, of which the native alphabet does not correspond to ours, or where the language is unwritten, the reader must expect some trifling inconsistencies, owing partly to our own irregular orthography. We have followed chiefly the Hydrographic Office, which employs the Italian vowels, with some modification. Thus, *a* as in *father*, *ai* as i (English) in *shine*; *au* as ow (English) in *cow* (Dutch ow); *e* as a (English) in *face*; *u* (or *ou* in some cases) as oo (English) in *fool*, or u in *sure* (French *ou*, Dutch *oe*). For ex., *Apia*, pronounced Ah-pee-a; *Mitiéro*, pronounced Mee-tee-air-o; *Manua*, pronounced Man-oo-a, not Manyúa. Cook's "Whytootackie" is spelt *Aitutaki*, as by the missionaries, who, wherever they have instructed the Pacific islanders in writing, have wisely given them the Italian vowels. Some names we preserve in forms already known to our seamen, as Nareenda, Toofooa (pronounced *Narínda*, *Toufoua*), &c., as also Otaheite (*Tahiti*), in which the *o* is not, however, absolutely, erroneous.

We have sometimes marked the pronunciation by an accent, as Battantá, Galápagos, Tongatábou, &c.

It must, however, always be borne in mind that each different people calls the same place by different names; this accounts for the discrepancies in names given to numerous islands.

Notation and Details. Everything in parentheses is additional information (to be explained under the Symbols), but which does not relate to the position.

Ex. Col. (30) C. Xyli (pk. 1040 f., N 1′·5) . . . denotes that there is a pk., &c., but the *position* is of C. Xyli.

Col. (55) Ras Gurdim ⊥ (rk S.E. 3m.) denotes there is a rock, &c., but the *position* is of Ras Gurdim.

Col. (81) Pt. Sipang, a rk (rks. 5m.) . . . denotes a rk. (awash) off Pt. S—, and rks. also 5m. out, but the *position* is that of the rock close off.

The seaman must draw no conclusions from the *absence* of details; he is not, for example, to infer that a place is safe merely because it is not marked dangerous.

Uses of the Table. This Table has, in navigation, two applications: 1st. It furnishes points of departure in leaving and in making the land, under which head are included, also, islands made in passages, and dangers to be avoided in shaping the course; 2nd. It gives the positions of ports and anchorages for the more complete regulation of the chronometer. Places, therefore, not belonging to one or the other of these two classes are unnecessary, because, in such circumstances, generally, the ship is either in pilot-water, or is navigated by the chart alone.

Lights, however, are inserted in greater number, because a ship in a fog may pass an outer light unseen, and learn her position from an inner one.

1. *Arrangement of the Positions.*

It is proper here to describe the principles on which this Table has been constructed, and to which allusion was made in the preface to the first edition.

It will be admitted, as remarked (pref. p. viii), that the *relative* positions of places are of much greater consequence in navigation than their *absolute* positions. For no astronomical observations taken at sea can be implicitly depended upon within at least one minute, and the chronometer, in consequence of not preserving exactly the same rate, ceases, after some days, to afford the true longitude of the ship. Since, therefore, the absolute longitude of the ship herself cannot be determined with certainty, the knowledge of the precise longitude of any position, as a rock, or a shoal, which she may be near, is but of little service. But, on the other hand, a tolerably good account of the ship's change of place, in short intervals of time, is afforded by a chronometer even of inferior quality, and hence it becomes of paramount importance that the places which the navigator employs as points of departure should be rightly placed *with respect to each other*, whether they are in their true positions or not.

Previously to Cook's voyages, which may be considered as the commencement of modern hydrography, the only method (besides the rude and imperfect determination of the ship's run) of obtaining the longitude of every new land made, was the lunar observation. But as that method, from its inaccuracy, fails altogether in exhibiting truly relative positions (No. 1008), chronometers were employed in combining together the results of observations taken at different places, of which numerous instances are recorded by Horsburgh in his East India Directory. Since, however, the observations made at two places are not in general equally good, this method of combining observations with chronometric differences has the disadvantage of impairing the better determination of the two, and in consequence throws a difficulty over the connexion of either of them with a third place better known. Succeeding navigators, proceeding in the same way, have obtained other results of observation, and other chronometric differences; and, in consequence, the hydrographer who has not the means afforded him of instituting a critical examination of the several positions, or of their connexion with each other, is driven to the necessity of taking a mean between each new result and those adopted from former navigators, and thus the whole mass of positions is kept in a state of perpetual fluctuation, from which it is impossible that universal precision can ever be obtained.

In marine surveys, again, different meridians have been assumed, and different longitudes of the same meridian. In some cases the long. of the meridian assumed has not been given; in others, the meridian itself has not been specified at all.

If, however, instead of thus throwing open the discussion of every place at each new voyage of discovery or surveying expedition, and unsettling all that had previously been done, without any assurance that the new series of positions would not in its turn be unsettled again, navigators and hydrographers would agree to *consider*, for the time being only, certain important stations, as already established in longitude, whether really so or not, with the view of referring all the subordinate positions to them, the indistinctness which now hangs over absolute and relative position would be forthwith cleared up. The question would be narrowed into the determination of *chronometric differences* alone, until favourable opportunity occurred for the definitive determination of a fundamental position. Accurate chronometric measures would be no longer lost to the world by being merged in the uncertain results of a few astronomical observations; and the labours of each navigator would always maintain their proper value, instead of being set aside, as they must inevitably be, on the appearance of a new survey, in which the data are exhibited in a distinct form. The works of different navigators, and of the navigators of different countries, could be brought into immediate comparison, a task which is at present often difficult and unsatisfactory, if not impossible. The labours of the hydrographer would be materially simplified; and as the points to which inquiry should next be directed would, by this system, be distinctly brought into view, the whole subject would advance steadily to its ultimate perfection.

The following instances may be cited in illustration:—The long. of Rio de Janeiro (Fort Villagagnon) had been by some stated to be 43° 15′, by others 43° 9′, while both parties adopted 56° 13′ as the long. of Monte Video (Rat Island). Now the true D. Long. of these places is $52^m\ 18^s$, probably within 1^s or 2^s, certainly within 4^s; but the diff. of 43° 15′ and 56° 13′ is $51^m\ 52^s$, or an error is admitted on one side of 26^s in a run of about 10 days. Had attention been earlier directed to differences of longitude as measured from fundamental points, such inconsistencies would speedily have disappeared.

Accordingly, it was proposed (Naut. Mag. 1839, On the longitudes of the principal maritime points of the globe) to adopt certain points under the name of *Secondary Meridians*, this general term being used to distinguish them from the *prime* meridians, as Greenwich, Paris, &c., from which the longitudes in the tables or on the charts must be reckoned. The longitudes (from Greenwich) accepted for the *Secondary Meridians*, on which Table 10, and the Admiralty Charts now (1898) depend, have been amended from Telegraphic determinations to 1887.* The points selected are so far distant from each other that the errors of their relative positions could not be easily discoverable by the ship's chronometers; and they must themselves depend on astronomical observations, of which it is important to remark, the number necessary for an unimpugnable determination appears to be very great. The Secondary Meridians, with the districts for which they are intended generally to serve, and their adopted longitudes, *from Greenwich*, are as follows:—

* The number of Secondary Meridians in the last edition was 25; considerable corrections and additions have now been made.

Table of Longitudes accepted for Secondary Meridians.

SHORES OF ATLANTIC OCEAN, AND NEIGHBOURING SEAS.

	° ′ ″		h. m. s.	
Copenhagen (*Observatory*)	12 34 48 E.	=	0 50 19·2	Kattegat, Coasts of Norway; Sweden.
St. Petersburg (*Pulkowa Observatory*)	30 19 40 E.	=	2 01 18·7	Baltic, White, and Black Seas.
Paris (*Observatory*)	2 20 15 E.	=	0 09 21·0	Coasts of France, West coast of Italy; Algeria.
Lisbon (*Dome of Royal Observatory*)*	9 11 10 W.	=	0 36 44·7	Coasts of Spain and Portugal.
Cadiz (*San Fernando Observatory*)	6 12 24 W.	=	0 24 49·6	
Pola Observatory	13 50 45 E.	=	0 55 23·0	Adriatic.
Malta (*Spencer's Monument*) †	14 30 40 E.	=	0 58 02·7	West coasts of Italy, Greece, Sicily; North coast of Africa.
Gibraltar (*Dockyard Flagstaff*) ⊕	5 21 27 W.	=	0 21 25·8	
Alexandria (*Lighthouse*)	29 51 40 E.	=	1 59 26·7	Egypt and Syria.
Smyrna (*Mill on Daragaz point*)	27 09 42 E.	=	1 48 38·8	Grecian Archipelago.
Constantinople (*St. Sophia*)	28 58 59 E.	=	1 55 55·9	Black Sea.
Madeira, Funchal (*British Consul's House*)*	16 54 30 W.	=	1 07 38·0	Azores, Madeira, Canary and Cape de Verde islands; West coast of Africa to Fernando Po.
Madeira (*Fort St. Jago*)*	16 53 53 W.	=	1 07 35·6	
Madeira (*Pontinha*)‡	16 55 01 W.	=	1 07 40·1	
Porto Grande, Cape Verde Islands (*Flagstaff in front of Brazilian Submarine Telegraph Co.'s Office*)*	24 59 22 W.	=	1 39 57·5	
Newfoundland, St. John's (*Chain Rock Battery*)	52 40 47 W.	=	3 30 43·1	Newfoundland and Labrador.
Halifax, Nova Scotia (*Naval Yard Observatory*)§	63 35 21 W.	=	4 14 21·4	British North America and Canada.
Boston, United States (*Cambridge Observatory*)	71 7 39 W.	=	4 44 30·6	United States; North America.
Key (Cay) West, U.S. Naval Storehouse (*Observing Spot*)‖	81 48 24 W.	=	5 27 13·6	
Key (Cay) West (*Lighthouse*)‖	81 48 04 W.	=	5 27 12·3	

* U.S. Telegraphic determination in 1878–9 from Greenwich. Published by U.S. Government, 1880.

† Telegraphic determination, 1875, from Berlin, by Professor Auwers and Dr. Gill

⊕ Telegraphic determination from Malta by H.M.S. *Sylvia*, 1886.

‡ Depending on being 1′ 8″ west of Fort St. Jago by chart.

§ Telegraphic determination in 1851 and 1872 from Washington, and from Greenwich.

‖ U.S. Telegraphic determinations in 1875–6 from Washington. Published by U.S. Government, 1877, No. 65.

Place	° ′ ″	h. m. s.	
Vera Cruz (*San Juan de Ulloa Lighthouse*)*	96 07 57 W. =	6 24 31·8	West Indies.
Havana (*Morro Lighthouse*)†	82 21 30 W. =	5 29 26·0	
Santiago de Cuba (*Blança Battery, South angle*)†	75 50 30 W. =	5 03 22·0	
Port Royal, Jamaica (*Fort Charles*)†	76 50 38 W. =	5 07 22·5	
Aspinwall (*Aspinwall Lighthouse*)†	79 54 45 W. =	5 19 39·0	
San Juan de Puerto Rico (*Morro Lighthouse*)†	66 07 28 W. =	4 24 29·9	
Virgin Islands, St. Croix (*Lang's Observatory, centre of Transit Pier*)†	64 41 17 W. =	4 18 45·2	
St. John, Antigua (*North tower of Cathedral*)†	61 50 28 W. =	4 07 21·9	
St. Pierre, Martinique (*St. Marthe Battery*)†	61 11 12 W. =	4 04 44·8	
Bridgetown, Barbados (*Flagstaff of Rickett's Battery*)†	59 37 18 W. =	3 58 29·2	
Port Spain, Trinidad (*Flagstaff of Water Battery*)†	61 30 38 W. =	4 06 02·6	
St. Thomas (*Fort Christian*)†	64 55 52 W. =	4 19 43·5	
Para (*Portico of Custom House*)‡	48 30 01 W. =	3 14 00·0	East coast of South America; Brazil.
Pernambuco (*Lighthouse near Fort Picão*)‡	34 51 56 W. =	2 19 27·8	
Bahia (*San Antonio Lighthouse*)‡	38 32 05 W. =	2 34 08·4	
Rio de Janeiro (*Fort Villegagnon*)‡	43 09 29 W. =	2 52 38·0	
Monte Video (*Rat Island*)‡	56 14 00 W. =	3 44 56·0	
Monte Video (*S.E. tower of the Cathedral*)‡	56 12 15 W. =	3 44 49·0	
Buenos Aires (*Cupola of Custom House*)‡	58 22 14 W. =	3 53 29·0	

INDIAN OCEAN AND RED SEA.

Place	° ′ ″	h. m. s.	
Cape of Good Hope (*Government Observatory*)§	18 28 40 E. =	1 13 54·7	South Africa, Madagascar, Seychelles.
Zanzibar (*British Consulate*)‖	39 11 08 E. =	2 36 44·5	Adjacent African Coast.
Aden (*Submarine Telegraph Office*)¶	44 58 57 E. =	2 59 55·8	Gulf of Aden.
Aden (*Local Telegraph Office*)	44 59 07 E. =	2 59 56·5	
Aden (*Observation spot, Ras Marbut*)	44 58 31 E. =	2 59 54·1	
Suez (*Port Ibrahim*)**	32 33 30 E. =	2 10 14·0	Red Sea.
Mauritius (*Martello tower, Fort George*)††	57 29 00 E. =	3 49 56·0	Madagascar — African Coast.
Bombay (*Observatory*)¶	72 48 58 E. =	4 51 15·9	Persian Gulf, West Coast of India & adjacent sea.

* U.S. Telegraphic determinations, 1883–4, from Washington. Published by U.S. Government in 1885, No. 76.

† U.S. Telegraphic determinations in 1875–6 from Washington. Published by U.S. Government, 1877, No. 65.

‡ U.S. Telegraphic determinations in 1878–9 from Greenwich. Published by U.S. Government, 1880.

§ Telegraphic determinations in 1881, by Dr. Gill from Aden.

‖ Telegraphic determination, 1881, by Dr. Gill from the Cape of Good Hope

¶ Telegraphic determination, India Trigonometrical Survey, 1878.

** Transit of Venus expedition, 1874.

†† Transit of Venus expedition, 1874 (meridian distance from Rodriguez).

	° ′ ″		h. m. s.	
Madras (*Observatory*)* - -	80 14 51 E.	=	5 20 59·4	Bay of Bengal.
Andaman Islands Port Blair (*Observatory, Chatham Isd.*)	92 43 00 E.	=	6 10 52·0	Andaman Islands.

JAVA, CHINA, AND JAPAN SEAS.

Batavia (*Observatory*)† - -	106 48 37 E.	=	7 07 14·5	W. Coast Sumatra, Java Eastern Archipelago.
Banjuwangi (*Fort Utrecht*)‡ -	114 22 55 E.	=	7 37 31·7	Adjacent islands.
Singapore§ (*Green's transit pier in rear of Master Attendant's Office*)‖	103 51 15 E.	=	6 55 25·0	Malacca Strait, South part of China Sea, Palawan.
Cape St. James (*Lighthouse*)‖ -	107 04 55 E.	=	7 08 19·6	Coast of Cochin China.
Manila (*Cathedral*)‖ - - -	120 58 06 E.	=	8 03 52·4	Philippine Islands.
Hong Kong (*Cathedral*)‖ - -	114 09 31 E.	=	7 36 38·1	Coasts of China.
Hong Kong (*Observatory Kaulung*)	114 10 25 E.	=	7 36 41·7	
Hong Kong (*Palos Pier*) - -	114 09 43 E.	=	7 36 38·8	
Amoy (*Kulangseu Signal Staff*)‖	118 04 03 E.	=	7 52 16·2	
Shanghai (*British Consulate Flag-staff*)‖	121 28 55 E.	=	8 05 55·7	Yellow Sea and Korea.
Vladivostok‖ (*Scharnhorst's Station*)	131 52 44 E.	=	8 47 31·0	Russian Tartary.
Nagasaki (*Minage Point*)‖ -	129 51 13 E.	=	8 39 24·9	Japan.
Yokohama (*Flagstaff English Victualling Depôt*)‖	139 39 13 E.	=	9 18 36·9	

AUSTRALIA, TASMANIA, AND NEW ZEALAND.

Sydney (*Observatory*)¶ - -	151 12 23 E.	=	10 04 49·5	Australia and adjacent islands.
Sydney (*Fort Macquarie*)** -	151 13 00 E.	=	10 04 52·0	
Moreton Bay (*Cape Moreton Lighthouse*)††	153 28 00 E.	=	10 13 52·0	Queensland.
Townsville (*Flagstaff Pilot Hill*)⊕	146 49 54 E.	=	9 47 19·6	
Cooktown (*Boatshed at inner end of Jetty, Pilot Station*)⊕	145 15 12 E.	=	9 41 00·8	
Cape York (*Sextant Rock*) -	142 32 48 E.	=	9 30 09·2	Torres Strait and New Guinea.
Samarai (*Dinner I.*) *China Strait (Observation spot)*φ	150 39 47 E.	=	10 02 39·1	
Port Essington (*Site of old Government House*)	132 09 18 E	=	8 48 37·2	North-west Coast of Australia.
Port Darwin (*Transit pier, east extreme of cable House*)¶	130 50 37 E.	=	8 43 22·5	
Swan River (*Scott's Jetty*)†† -	115 44 30 E.	=	7 42 58·0	West Australia.
Adelaide (*Snapper point*)‡‡ -	138 30 50 E.	=	9 14 03·4	South Australia.
Port Phillip (*Melbourne Observ.*)‡‡	144 58 32 E.	=	9 39 54·1	Victoria.

* Telegraphic determination, India Trigonometrical Survey, 1878.

† Telegraphic determination from Singapore by Professor Oudemans in 1871, adopting U.S. determination of Singapore, 1881–2.

‡ Telegraph determination through Singapore and Port Darwin (in connection with Greenwich), in 1883. Communicated by Mr. Ellery, Government Astronomer at Melbourne, in letter dated January 8, 1885.

§ From Green's transit pier the old Observation spot in Fullerton battery, Singapore, bears S. 5° 37′ W. (true) distant 169 feet.

‖ U.S. Telegraphic determination, 1881–2. Published by U.S. Gov., 1883, No. 65b.

¶ Telegraph determination through Singapore and Port Darwin (in connection with Greenwich), in 1883.

** Depending on Fort Macquarie being 47″ E. of Sydney Observatory on chart.

†† Depending on Fort Macquarie, Sydney, being in 151° 13′ 00″ E.

⊕ Telegraphic determination from Sydney by H M. ships *Dart* and *Lark*, 1886.

φ Meridian distance from Townsville, H.M.S. *Dart*, 1886.

‡‡ Telegraph determination through Singapore and Port Darwin (in connection with Greenwich), in 1883.

	° ′ ″	h. m. s.	
Tasmania. Hobart (*Site of Fort Mulgrave*)*	147 20 35 E.	= 9 49 22·3	Tasmania.
New Zealand. Wellington (*Pipitea point*)	174 47 02 E.	= 11 39 08·1	New Zealand.
New Zealand. Mt. Cook (*Observatory*)†	174 46 38 E.	= 11 39 06·5	New Zealand.

PACIFIC OCEAN.

Levuka, Ovalau (*Site of old School-house*)	178 51 00 E.	= 11 55 24·0	Fiji Islands, South-west Pacific Ocean
Tahiti (*Point Venus extreme*)	149 29 00 W.	= 9 57 56·0	South-east Pacific Ocean.
Honolulu (*King's Cottage*)†	157 51 53 W.	= 10 31 27·5	North Pacific Ocean.
Esquimalt harbour (*Duntze Head, site of Observatory*)	123 26 45 W.	= 8 13 47·0	Vancouver Island and British Columbia.
San Francisco (*Fort Point Lighthouse, south side of entrance*)‡	122 28 38 W.	= 8 09 54·5	California.
San Salvador, La Libertad (*Pier head*)§	89 19 22 W.	= 5 57 17·5	Mexico and Ecuador.
Panama (*Cathedral, South tower*)‖	79 32 12 W.	= 5 18 08·8	Mexico and Ecuador.
Panama (*North-east bastion*)‖	79 32 03 W.	= 5 18 08·2	West Coast of South America.
Paita (*Cathedral tower*)§	81 07 17 W.	= 5 24 29·1	West Coast of South America.
Lima (*South tower of Cathedral*)§	77 00 02 W.	= 5 08 10·6	West Coast of South America.
Callao (*San Lorenzo Lighthouse*)§	77 15 44 W.	= 5 09 02·9	West Coast of South America.
Arica (*Church spire, Iglesia Matrix*)§	70 20 00 W.	= 4 41 20·0	West Coast of South America.
Valparaiso (*Cupola of Exchange*)§	71 38 36 W.	= 4 46 34·4	West Coast of South America.
Magellan Strait, Sandy point (*Boat-house*)¶	70 54 03 W.	= 4 43 36·2	Magellan Strait.
Magellan Strait, Port Famine (*Fitz Roy's Obs spot*)**	70 56 37 W.	= 4 43 46·5	Magellan Strait.

Meridians adopted in the construction of Foreign Charts.

Russia, Sweden, Denmark, Norway, Holland, Austria, and the United States of America adopt the Meridian of Greenwich.

France adopts the Meridian of Paris, assumed to be in Long. 2° 20′ 15″ = 0h 09m 21·0s E. of Greenwich.

Spain adopts the Meridian of San Fernando, Cadiz, assumed to be in Long. 6° 12′ 24″ = 0h 24m 49·6s W. of Greenwich, or 05′ 22″ E. of Old Observatory.

Portugal adopts the Meridian of the Observatory, assumed to be in Long. 9° 11′ 10″ = 0h 36m 44·7s W. of Greenwich.††

The Pulkowa Observatory of St. Petersburg (sometimes referred to in Russian Charts) is assumed to be in Long. 30° 19′ 40″ = 2h 1m 18·7s E. of Greenwich.

The Royal Observatory of Naples (sometimes referred to in Italian Charts) is assumed to be in Long. 14° 15′ 7″·3 = 0h 57m 00·5s E. of Greenwich.

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* Transit of Venus expedition of 1874.

† Telegraphic determination from Sydney, 1883.

‡ U.S. Telegraphic determination in 1870 from Washington.

§ U.S. Telegraphic determinations, 1883–4, from Washington. Published by U.S. Government in 1885, No. 76.

‖ U.S. Telegraphic determinations in 1875–6 from Washington. Published by U.S. Government, 1877, No. 65.

¶ From Professor Auwers (German Transit of Venus expedition), 1882. By meridian distances measured in H.M.S. *Nassau*, 1866–69, from Rio de Janeiro (Fort Villegagnon being considered in 43° 09′ 29″ W.), the longitude of Sandy Point is 70° 54′ 06″ W. By meridian distance measured in H.M.S. *Sylvia*, 1882, from Monte Video (Rat Island being considered in 56° 14′ 00″ W.), the longitude of Sandy Point is 70° 54′ 08′ W.

** Depending upon Sandy Point, being in 70° 54′ 03″ W.

†† The longitude of Lisbon castle deduced from the U.S. telegraphic longitude of the Lisbon Royal Observatory (in 9° 11′ 10″ W.) is 9° 07′ 55″ W

[1.] *Symbols denoting the Values of the Determinations*

The symbols ○ ⊖ ⦶ ⊕ attached to certain places, indicate the degree of precision with which their positions are supposed to be known.

The circle represents the horizon of the place; the line thus — a parallel of latitude; and the line thus | a meridian. Accordingly, the meaning of the symbols, generally, is as follows:—

1. ○ implies *undetermined* either in lat. or long.
2. ⊖ implies determined in *latitude* only, or the longitude wanting
3. ⦶ implies determined in *longitude*, or the latitude wanting.
4. ⊕ implies determined both in latitude and longitude.

A dot under the ○ implies *aggravated uncertainty.*

As very few places are *determined* in the strict sense of the word, while, on the other hand, no known place can be said to be absolutely *undetermined*, the sense attached to these two words must be defined by the purposes which the symbols are intended to serve in hydrography or in the navigation of a ship.

The different *degrees* of determination are indicated by the *position* of the symbol.

1. The symbol ○ denotes a doubt of not less than 2′ of lat., or somewhat more of long. It is used when the authorities differ from each other, or themselves: thus Capt. W. F. W. Owen places Cape Nun in 28° 41′ N., and Lieut. Arlett in 28° 46′, the long. not being well known.

This symbol placed after the name in the side column denotes that the district generally is imperfectly known, as parts of the Eastern Archipelago.

2. The symbol ⊖ indicates the latitude well enough determined for ordinary purposes, but the longitude defective. It occurs frequently.

3. The symbol ⦶ occurs rarely.

4. The symbol ⊕ *after* the name of a *point*, implies a tolerably precise determination.

It would have been prefixed to Pulo Aor, col. 67, but this island is 2 m. from E. to W., and the precise point of observation is not specified.

When placed *after* the name in the *side column*, it implies trigonometrical survey, subject to future, though probably small, correction; as, for ex., parts of our own coasts, the coast of Holland, Iceland, Greece, Italy, India, Corsica, R. St. Lawrence, Massachusetts, Rhode I., &c.

When placed *before* the name in the *side column*, it denotes final determination. The coasts so distinguished are part of our own, and it should have been attached to France.

This final characteristic cannot obviously be applied until the secondary meridian is fixed.*

When no symbol is attached either to the district or to the points of

* The attention of seamen is particularly called to the considerations in the text. By having distinctions established, in the Table, between correct and uncertain positions, the navigator will have his circumspection awakened on approaching land of doubtful situation; and on leaving it again he will be enabled to avoid errors or perplexity in his reckoning consequent on adopting an erroneous point of departure.

It is also hoped that a further important end will be answered by the use of the symbols, and that intelligent individuals, thus made aware of the deficiencies or errors of the charts and tables, will, for the benefit of navigation and hydrography, avail themselves of opportunities to determine or verify doubtful positions.

the coast, it is implied that we are not in possession of such additional evidence as might serve to form a definite opinion on the accuracy of the several points.

The Secondary Meridians take no symbol, since, though not all finally determined, they are assumed as the leading points of the arrangement.

2. *Description-Symbols.*

The importance of abbreviations and symbols in saving time in writing is so generally felt that most persons who write much, habitually employ certain signs, intelligible to themselves, to save the tedious repetition of the same letters and syllables.

Suitable and expressive symbols are, however, not merely a convenience to the writer, but afford, in general, the advantages of distinctness, explicitness, and economy of time to the reader, together with another of still greater consequence, namely, certainty. This last assertion will not, perhaps, be so generally assented to as the former, but the truth of it is easily established. For example, a seaman in any particular part of the world opens a book to learn where he may find a good anchorage. His eye naturally looks for the word "anchorage" or "anchor," as it would for a sign or symbol. Having found the word, he is then obliged to read the entire sentence which contains it, in order thoroughly to comprehend the meaning; since, without a clear understanding of all that is said about anchorage, it is not safe to act. Now this sentence, though it relates, as we suppose, in some way to anchorage, may not contain at all the information that he requires; it may, for example, allude to some ship having partially or unsuccessfully searched for an anchorage, or it may merely intimate that no good anchorage has been found between some place in the neighbourhood and another more distant. Moreover, it is often difficult, from the arrangement of the matter, to know the precise point the account refers to, without reading back. If, on the contrary, the reader's eye catches the symbol ⚓, or this symbol so modified as to express with clearness "no anchorage," or "good anchorage," or "bad anchorage," or "anchorage at times only," or "confined to a small space," his work is done at once; he seizes in an instant the information that is given, and his mind is altogether unembarrassed by circumstances of narration, or the consideration of suppositions, inferences, and conditions, which often tend to obscure language in full development.

There are numerous other matters which, on like grounds, demand conspicuous indication: such as the dimensions of islands and shoals the leading particulars of dangers; the character and appearance of land, for the purpose of distinguishing one point from another; the class of vessels to which a harbour is adapted; channels; landing-places; as also notice of water, refreshments, and fuel, &c.

But, besides the mere notice or indication, it is often no less necessary to denote *quality*, or character, as good or bad; thus the seaman should know whether the inhabitants of a place he may visit are likely to assist his wants or to massacre his crew; that is, whether the character of the people is friendly or hostile.

The consideration of *quantity* has a powerful influence on the indications of language. One place has some trees upon it; another is well wooded; another densely wooded. It is entirely by increase of quantity that we pass from *trees* to *wood*, and from *wood* to *forest*. In like manner, it is no less the abundance than the superior quality of the water, refreshments, &c., that determine the selection of the place at which to obtain supplies.

The following cases exemplify the great conciseness of expression and clearness of symbols which may be considered as appropriate.

☐$^{18}_{6}$ A harbour for smaller sized vessels (*i.e.* of which the depth is not always so much as 3 fathoms) having 18 feet water at high water, and 6 feet at low water, spring tides.

The symbols represent twenty words, in the space of two or three letters, besides indicating the rise of the tide, which is found by subtracting the lower depth from the upper.

⊞$^{18}_{0}$ A harbour (as above), having 18 feet at high water, and dry at low water.

These symbols represent eighteen words.

w′ Water, in abundance, and of good quality.
⊕ 4m. Lying North-north-east and South-south-west, and extending 4 miles.

The last symbols represent twelve words; and the compass symbol exhibits to the eye, without reference to the names of the points, the two opposite quarters of the compass in which the line of direction is contained.

The reader must be distinctly informed that the symbols do not, in any way, interfere with the usual purposes of this Table, and therefore he may, if he please, disregard them altogether. He will, however, never do wrong in taking any known sign in its usual sense, as those symbols and abbreviations which have come into general use are here adopted as the groundwork of the system. The seaman who may find some little difficulty in learning to read these signs at first, may wish that the information they contain was printed at greater length. But there is no room for this, as the Tables are already too bulky; and it is only through the remarkable condensation afforded by the symbols that such information can be given at all. But when he has once taken the trouble to learn the system, which he will find very easy, he will, on the contrary, be induced to prefer the short and concise, positive, and unmistakable symbol to the tedious, indiscriminative, and not seldom obscure process of language written at length.

There is no doubt that proper symbols would be of great advantage to seamen in consulting books and tables relating to Maritime Geography, and also Charts; and we shall now enter on the system of which the first steps occurred to me while preparing the second edition of this work in 1841.

[1.] *General Rules for the Employment of the Symbols.*

1. An abbreviation, or an appropriate symbol, is assigned to each point of information; as lt. light; ⚓ anchorage; w water.*

2. A zero, or cipher, below, and to the right, denotes *no*, or *none*; as w_0 *no* water, ⚓$_0$ *no* anchorage.

Note.—This zero is of as much consequence as the symbol itself, and is the only secondary or subordinate sign that is so. It may, at first sight, seem awkward to write the symbol, and then to destroy it, as it were, by the zero; but it is the necessary process of thought: when we wish to say "no water," we necessarily direct the mind to *water* as the subject, and then add that there is *none* of it. To leave out the symbol altogether would not express the *privation* of the *thing*, but merely that we had nothing to say upon it.

* In employing these signs it is essential that capitals and small letters should not be confounded.

3. A symbol inverted has its meaning reversed : thus the boathook, ⸸ *landing*, inverted, as ⸸, would denote *embarking*.

4. A hollow letter implies *temporary* or occasional, in opposition to the solid letter implying *permanent*; thus F (after lt.) denotes a *permanent* fixed lt.; 𝔽 an *occasional* fixed lt.

5. The symbol repeated denotes the same thing at *different places*, or not everywhere; as ⚓ ⚓, anchorages, in *certain places*.

6. A symbol followed by the same with the zero sign denotes *at times*; as ww_o, water *at times* (literally, water and no water).

Note.—This is, in general, equivalent to the hollow letter above; but all symbols cannot conveniently be printed in the hollow form.

[2.] *Component Signs.*

These are used only in combination with others.

1. The line — denotes the *surface of the sea*; everything above this is, accordingly, conceived as above the level of the sea, and below it, below that level: as r̲k̲. a rk. always *above* the surface; r̄k̄. a rk. always *below* the surface, i.e. sunken.

A symbol between two such lines, that is, between *two levels*, denotes *awash*, as r̲̄k̲̄. Such is, for example, the Vrach, off Alderney, which shows only at low spring-tides.

2. A line thus | denotes vertical.

3. The cross +, with a number denoting the point in the proper quarter, constitutes the Compass Symbol; thus +⁶ denotes ENE.

The cross with the N. pt. turned a little to the *right* would denote magnetic, as affected by *Easterly* Variation; turned to the *left*, as affected by *Westerly* Variation.

4. A square, or oblong, implies *enclosure*, whether partial or total; as ⊞, an anchorage enclosed, represents *harbour*.

5. Brackets [1] imply *within limits*; as [⚓] anchorage confined to a narrow or limited space; [2] a shoal patch, with 2fms. on it, that is, 2fms. confined to a small space; [↟] trees confined to a small space, a clump.

When a letter denoting dimension (as c, f, m), with or without a number, and inserted in brackets, follows the word Id., or a term describing a danger, it indicates *extent*; thus [1m], "within the limits of 1 mile," that is, *extending* 1 mile. [c] A cable's length, or so, in extent. [3c] Three cables in extent.

[3.] *Subsidiary Signs.*

These are the dots under, the apostrophes over, and the accents or letters to the right of, the symbol.

Note.—The subordinate signs follow, and never precede, the symbol.

They denote, 1st, *Quantity*; and 2nd, *Variety*.

I. The *quantity-signs* are the dots and apostrophes.

(1.) The *dot* (below) denotes *plenty*, abundance; as ẉ plenty of water. The dot has this acceptation in the weather symbols, p. 156. Two dots denote a greater abundance, and three dots express the highest degree for which language has a term : thus ↟ a tree or trees; one dot would denote many trees; ↟̤ wood (well wooded), and three dots would denote forest, or densely covered.

(2.) The *apostrophe* (above) implies *scarcity*; as w' water not plentiful. This sign is adopted from its use in contractions, as in such words as can't; whence it becomes associated with the idea of diminution. It is placed above in order still further to contrast with the plenty-sign or dot, and to prevent the possibility of confounding one with the other, even in the case of almost total obliteration. Two apostrophes would denote great scarcity, and three, the almost entire absence of the thing indicated.

II. The *variety-signs* are the letters, accents, or any other symbols as convenient, to the right of the symbol, and above or below it.

(1.) The most general of these is the accent, which denotes some variety of the thing symbolised: thus N, S, E, W, denoting the true points of the compass, N′, S′, E′, W′, denote the *magnetic* points of the compass.*

(2.) In things having quality, that is, which may be good or bad, the accent is placed *above* to denote *superior*, or good quality, as opposed to *inferior*, or *bad* quality, denoted by the accent *below*; as w′ good water, $w_{\prime}$ bad ditto; ⚓′ good anchorage, $⚓_{\prime}$ bad ditto.

Two accents would denote the next, and three the highest, degree for which language has a term: as w″ water very good, w‴ ditto excellent; $⚓_{\prime\prime}$ anchorage very bad, $⚓_{\prime\prime\prime}$ the worst possible, or where a ship should anchor only in great distress.

(3.) The letters used for these secondary distinctions must obviously take their signification from the thing symbolised, and likewise their position above or below: as w^{R} *river* water, good; or w_{R} ditto, bad. P_{R} people *run* (from ships), who are, generally, the worst characters.

As the subsidiary signs are independent of each other, any number of them may be employed at convenience: as $\dot{w}'$ water scarce, but good; $\dot{w}_{\prime}$ water scarce and bad; $\bar{\bar{w}}_{\prime\prime}$ water by digging, in plenty, but very bad.

The notation is thus comprised in a primary or class *symbol*, a *quantity-sign*, and a *variety-sign*.

The vacant spaces following the names of places being, by this plan, turned to account, much important information is inserted without increasing the size of the volume.† It is also proper to observe that, as the signs represent ideas or things, and not words (with a few exceptions), the system is independent of any particular language.

The abbreviations and symbols used in the Table are, for reference, alphabetically arranged in the following

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* A special notation for this purpose is much required. In Purdy's "Sailing Directories," both the magnetic and the true bearing are given in order, as "the bearing and distance of the Capes Teulada and Malfatan are E. ¾ S. [*E. ¾ N.*] 8 miles."

Here *E. ¾ N.* refers to the *true* compass; but this can only be known by referring to the notice at the beginning of the book, unless the reader is aware that the variation at the place is westerly. The italic letters are already required for those passages in which, from the importance of the remark, the whole sentence is italicised; but the notation E′ ¾ S′ presents every advantage which a notation should possess: it is perspicuous, unequivocal, concise in the extreme, and elegant.

We must be careful to accent *all* the letters: thus N′ E′, not N E′; for this last combining true N. and magnetic E., presents no idea which occurs in practice.

A second accent denotes, further, local deviation, as N″E″, which shews, at once, that there are two corrections necessary to reduce it to true NE. This notation would remove much of the difficulty which often arises in endeavouring to combine bearings taken under different circumstances.

This notation need not, from the nature of the case, appear in ships' logs.

† It is no part of our design to enter all information which can be conveyed in symbols. A few leading points have been inserted where it seemed advisable; the reader must refer for other details to the Sailing Directions, or to voyages. The symbols, however, will answer the further purpose of affording the means of making extracts, or of taking notes, of certain particulars, in a very small space, and in a very short time.

General View.

⚓ (Anchor) Anchorage for large vessels.
⚓′ good do. ⚓, bad do. ⚓₀ no do.

⚓ do. for smaller vessels.
⚓′ good do. ⚓, bad do.

Harbour for large vessels, or having always 3 fathoms water.

Harbour for smaller vessels, or having at times less than 3 fathoms.

The depth at H.W. and L.W. springs is denoted by the figures annexed above and below.

Ex. 1. $^{20}_{12}$, 20ft. at H.W. and 12ft. at low.

Ex. 2. $^{16}_{0}$, 16ft. at H.W. and dry at low water. When the depth at high water, of a harbour which dries at low water, is not known, it is expressed (for the present) by the letter n, implying some number not given; ex. Stonehaven, $^{n}_{0}$.

Note.—In cases in which these details are not well known vacancies are left, which will be filled up on a future occasion.

Ball.
1ʰ, Time ball dropped at 1 P.M.

bk. Bank

B. Bay.

bll. Bell.

bl. blue.

blk. black.

Birds. As birds frequent some places in preference to others, they may afford a means of identification.

(Boathook).—See Landing.

T Bold to.—See Component Signs, 1, 2.

[ ] Brackets.—See Component Signs, 5.

β Break, or breakers.
ββ₀ do. *at times.*

Brushwood (a tree without a trunk).

b Burn (or *fuel*).

b (fuel enclosed), a coal depôt; coaling station for steam-vessels.

On some of the shores of the Polar Sea, and elsewhere, b denotes *drift-wood.* In some places *peat,* as at New I. Falklands. Where trees or brushwood occur, the symbol b is omitted, as, though many woods do not burn when green, fuel may be picked up in such places.—See Table 11

C. Cape.

Cath. Cathedral.

c. Cable's length.

! (Note of admiration surprise), denotes Caution, or calls attention, as Current!

‖ Channel, or passage, passages.

‖‖ Several channels; ‖35, chan. with 35fms.; ‖₀ no channel.
At a river the symbol relates to the entrance.

Chap. Chapel.

Ch. Church.

b Coal depot.

Cocoa-nut tree, or trees; [ ] a clump of cocoa-nut trees; 2 [ ] two clumps do., and so on.

Compass symbol.—See Compon. Signs, 3.

crl. coral.

δ Danger, dangerous; δδ dangerous in different places.
δ₀ (no danger) safe.

d Days.

Depth of water, denoted by the no. under the mark —, as 4 four fms.; 3 f, 3 feet.
The depth is that at low water. The depth relates to the bar, where there is one.

Distance is expressed in leagues, or miles; as C. Lookout, rks. 1 l., implies rks. 1 league from the Cape; δ 2m., dangerous 2 miles out; δ₀ ½m., no danger, may be approached within ½ a mile, δ₀ ½ c., safe at ½ a cable distance; δ ⇗ 2 l. a danger NE. 2 leagues.

Dk. yd. Dockyard.

Dry, or above water.—See Comp. Signs, 1.

E East. E′ magnetic E.

Entrance.—See Channel.

extr. Extreme, extremity.

F after a light, denotes that the flame has a fixed, not a changing appearance.—See lt.

F denotes a lt. (flame) of a fixed character, but only shewn occasionally—See General Rules, No. 4, p. 399.

Fl. after a lt. denotes flashes.—See lt.

fl. Flag.

fl. st. Flag-staff.

Hd. Head.

h High.
ho. house.
hum. hummock.
I. Island.
The compass-symbol after an island shews the direction, or *lay*, of the longest diameter, and is followed by the length of this diameter in leagues, miles, or cables.
Ex. 1. ⅔ 3m. denotes NNW. and SSE. (true), and extending 3 miles.
Ex. 2. EW $6\frac{1}{2}$m. denotes lying E. and W. (true), extent $6\frac{1}{2}$ miles.
Note.—These bearings are all TRUE.
The bearing, though given to 2 points only, is near enough for the purposes required, as it can be in error only 1 pt. The distance is noted with more or less precision, according to the case, and is not always to be taken as an exact measure. When the extent is very small, the bearing or direction is omitted; as Rockal, [2c.], or 2 cables in extent.
I after a light, denotes intermitting.—See lt.
Is. Islands. The compass-symbol and distance following shew the extent and general direction of the group, as described above in Id.
The number after Is. denotes the number in the group, as Wallis Is. 9.
Ꝇ Landing (a boathook, the hook to the ground); $Ꝇ_o$ no landing; ꝆꝆ$_o$ landing at times; Ꝇ′ good do.; $Ꝇ_{,}$ bad.
L Leagues. When a number of leagues follows next to the name, it denotes the number of leagues the place is visible—as Tiger I. 17 l., denotes visible 17 leagues. When the l. stands next after a compass indication, it implies of course a distance measured in the given direction; as Is. ⅔ 5 l., islands NW 5 leagues.
l low.
lt. light. The capital letter next after the light denotes the *character of the flame*, as F fixed, I intermittent, R revolving, Fl. flashing or varied by occasional flashes, or rapid change in the intensity.
The number of feet (which stands the last among the particulars of the light) denotes the *height* of the lantern or flame above high water. Where this is not known, the range in miles is inserted.
When a lt. stands on a *summit*, the abbreviation sum. is inserted; when, therefore, sum. does not appear, the lt., however high, is usually not on the summit.
lts. The compass indication and no. of feet next after 2 lts, denote their *bearing and dist.* asunder—the spectator looking at them from the sea; thus, the Lizard lts., lying N 72° E and S 72° W, are seen in one, from a ship to the westward, or towards the ocean, in the direction N 72° E.
Note.—These bearings are all TRUE, and they are intended to afford a means of determining the state of the compass when the ship is in a line with the 2 lts. in one.
m. miles.
After a shoal or danger, denotes the distance; as rf. 3m., a reef 3 miles distant.
mid. middle.
Mk. or mk. mark.
mo. mouth.
Mt. mount.
N North. N′ magnetic N.
† Palm-tree.
( ) Parentheses, contains extra or additional information.—See p. 389
Passage.—See Channel.
Patch.—See Compon. Signs, **5.**
Penins. Peninsula.
P People—or peopled.
P_o Uninhabited.
P′ People of favourable character.
$P_{,}$—of unfavourable do.
pk. Peak.
Pt. Point, being part of a name, as Hartland Pt.
pt. point.
R River. After a lt. denotes *revolving.*
r red.
rf. Reef.
rf, rf. always dry; r̄f̄, rf. always covered; r̄f̄, rf. awash.
r Refreshments, that is, vegetables, fruit, and meat.
As fish is often procurable where there are neither vegetation nor inhabitants, it is expressed by the separate symbol r̄, denoting r under the water.
⦣ Rising gradually. ⁀ Rising in the middle, as I. Fuerte.
rk. Rock.
rk, dry; r̄k̄, sunken; r̄k̄, awash.
The number under a line, a 2, denotes the depth in fms. over a sunken rk.
rks. Rocks; a compass indication, with a number of miles or cables, denotes the extent, as described under Island.
rky. rocky.
S South. S′ magnetic S.
⌣ Saddle-shaped, as Huafo I., a valley.—See Sloping, Rising.
sd. Sand, or sandy.
This quality is noticed occasionally, as sand often affords water, it is used in cleaning, and turtles lay their eggs in sand.

shl. Shoal. A compass indication with m. or e., denotes the extent.—See Island.

The number under a line, standing next after shl. denotes the depth of water over the shoal, as Ridge $\frac{}{6}$.

Shoal patch.—See Compon. Signs, No. 5.

⟍ Sloping downwards, as Goose Cape.

⟍⊥ Sloping down to a bluff.

7 Sloping bottom, or change of soundings gradual, may be approached with safety by attention to the lead.

Sig. st. Signal staff, or station.

⊥ Steep, or precipitous (not absolutely vertical).—See Component Signs, 1, 2.

Note.—This is quite independent of *high*. A headland may be low yet precipitous.

T Steep to.

St. Saint.

Sta. Santa.

Tel. Telegraph.

⚘ Tree, trees; [⚘] a clump of trees: 2 [⚘] two clumps; 3 [⚘] three clumps.

⚘ well wooded.

✲ (A tree without a trunk), brushwood.

Vert. Vertical.

W West. W′ magnetic West.

w Water (for drinking).

w′ good do., $w_,$ bad do.

w_0 no water, ww_0 water *at times*.

w̄ do. (under the surface) to be got by digging.

The bearing and dist. following the w point out the place with reference to the position given, as Koron w′ N. 2m. denotes good water North 2m. of Koron.

w, wh. white.

The following examples exhibit the method :—

Ex. 1. Island, $\frac{\text{NE}}{\text{SW}}$ 7m., *h*, ⚘$_0$, ‖$_0$E, ⚓′ SW $\frac{}{8}$, ẇ′r_0, $P_,$. An island *lying* NE and SW, extending 7 miles; *high*; *no trees*; *no passage* to the *eastward*; a *good anchorage* on the *SW side* in 8 *fathoms*; where *water, scarce*, but *good*, is to be found, but *no* other *refreshments*; the *people* of *bad* character.

Ex. 2. Paddeway Bay. ⚓ [5m.] $\frac{}{10}$, r, δ_0. A *harbour for large vessels*, extending 5 miles, having 10 *fathoms* water; *refreshments* to be had; *no dangers*.

Ex. 3. Shoal, $\frac{\text{WNW}}{\text{ESE}}$ 4m., rk. at NW end, ⤳⤳$_0$, T, L_0. A shoal, *lying WNW and ESE* 4 *miles*; a *rock always above water* at the NW end, the *occasional* resort of *birds*, *bold* to, and no *landing* on it.

Ex. 4. N. Watcher, small, ⚘, (Omega Shls. E′bS′ ½m., δ, T) lt. R. 159f. N. Watcher, small, well wooded, Light Revolving 159 feet high. Omega shls. lie EbS magnetic, ½m., are dangerous, and steep to.

Ex. 5. Guase or Kenn I., $\frac{\text{NE}}{\text{SW}}$ 8m. *l*, ⚘, 7, r, w̄, $P_,$. Low, covered with trees, or wooded, soundings gradual, refreshments, water to be obtained by digging, people of bad character.

3. *Lights, Characteristics, &c.*

The lights shewn in lighthouses are divided into several classes, Fixed, Flashing, Revolving, Occulting, and Alternating (*see* p. 925). The fixed light maintains the same appearance; the other classes change, some alternating by slow degrees between bright and dim, some flashing more or less suddenly, and others varied by eclipses. Colour is also employed partially as a means of distinction. Lights are distinguished from each other also by the different intervals of time in which the changes succeed each other.*

It is to be borne in mind that every light which varies its lustre is liable, when seen from a distance, to become altogether invisible during the period of lesser brilliancy; that is, a revolving light may seem to be eclipsed. Also, elevated lights are often entirely obscured by clouds.

As objects painted white frequently disappear in fog, while objects of a red colour remain visible, buildings serving for marks are often painted with red and white stripes, or bands.

* Seamen are generally content with the mere fact of revolution or intermission, and do not trouble themselves to measure the interval. This, therefore, is an occasion on which it is very useful to be able to count seconds, for all persons do not carry seconds watches, and it is not always possible for the same person to hold the watch to a lamp and to see the light at the same instant.

The lighthouse, or building, being useful as a guide by day, many lighthouses are accordingly painted in order to answer this second purpose.

All the distances given in the Admiralty Light Lists and on the charts for the visibility of lights are calculated for a height of an observer's eye of 15 feet. The table of distances visible due to height, at end of each Light List, affords a means of ascertaining how much more or less the light is visible should the height of the bridge be more or less. The glare of a powerful light is often seen far beyond the limit of visibility of the actual rays of the light, but this must not be confounded with the true range. Again, refraction may often cause a light to be seen farther than under ordinary circumstances.*

The power of a light can be estimated by remarking its order, as given in the Light Lists, and in some cases by noting how much its visibility in clear weather falls short of the range due to the height at which it is placed. Thus, a light standing 200 feet above the sea, and only recorded as visible at 10 miles in clear weather, is manifestly of little brilliancy, as its height would permit it to be seen over 20 m. if of any power.

The Admiralty Light Lists, corrected yearly, should always be consulted as to the details of a light, as the description in the Sailing Directions may be obsolete, in consequence of changes made since publication.

4. *Compass-names of Points of Land.*

Navigators and hydrographers have not hitherto adopted any constant rule in the application of *compass-names* to the projecting angles of land. Thus, Krusenstern says (Mém. Hydr. ii. p. 283), "The north point of Owhyhee, which Vancouver calls the west point," &c. This extreme diversity of expression establishes the necessity of a systematic employment of such terms.

The north point of an island may be considered, 1. as that point which is to the northward of the middle or *body* of the island; or, 2. as the northernmost or *extreme* north point. In a circular island both terms agree, but in irregular forms they are ambiguous; thus Krusenstern calls the S. extreme of Atooi, "the S.E. pt.," probably from its position S.E.-d of the body of the island.

It will, perhaps, be admitted, that, in a purely practical subject, such a

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* It is not unlikely that a light may be found sufficiently powerful, by the addition of a proper reflector, to illuminate the clouds, and, in a fainter degree, the atmosphere itself, over a lighthouse. The pale light in which a distant town appears enveloped at night; the distinctness of the forms of the clouds over a large city, illuminated by its ordinary lamps; and the vivid glare diffused over the heavens by a fire, show that the atmosphere renders the reflected light visible at a considerable distance. It is merely a question of intensity. If a sunbeam were admitted through a hole in the earth in a dark night, it would appear in the atmosphere as a column of astonishing splendour. As the light suggested would have a conical or shaft-like appearance, and would exhibit no flame, its proper designation would be a *shaft-light*. The shaft might, by the disposition of the reflector, be vertical, or inclined seawards or landwards, or be kept in motion, and the effect would be a great relief to the already exhausted resources for varying the appearance of lights.

This idea of Raper's is now carried out, and the illumination of the clouds by the new Electric Flashing Light at Ushant has been seen from a distance of 70 miles.

mode of expression should be selected as is best adapted to *application*, provided no error be thereby involved. But, in this question, both efficacy in practice and precision of language concur in directing the use of terms according to their *absolute significations*. Thus, if we call a southerly point of Atooi the "S.E. pt.," we leave it doubtful whether there is land to the southward or not; and, therefore, a ship could not, without reference to the chart, venture to run; but if we call the south point by the proper term, this doubt is not suggested, since the word "south" declares that no other part of the coast projects so far to the southward.

Accordingly, in this work, the compass-names N., S., E., or W., denote the extreme projecting point in that direction, without regard to the figure of the rest of the coast.

A point which is an extreme both in latitude and longitude, as, for ex., the S.E. projecting Cape of Samar (Philippines) we call what it is, namely, the South *and* East extreme, and so of the S. and W., N. and E., N. and W. points.

[1.] *Ambiguous Terms.*

Another case in which serious ambiguity may arise from the want of critical rules in such matters, and which may with propriety be noticed here, occurs in such phrases as "the Lizard lights in one clear the Manacles to the eastward." This is intended to imply that the ship passes to the eastward of the *rocks;* but, by omitting all mention of the ship, the bearing might be supposed to relate to the rocks, as would be the case if another verb were put for "cleared," as "saw the M. to the eastward," in which cases the ship is clearly to the westward. If the sentence ran "clear the ship to the eastward," no obscurity could exist, yet "clear the M. to the eastward," also puts the ship to the eastward. There must be something very defective in an expression which keeps the same meaning when reversed.

It would be well to adopt the rule that the bearing specified should relate to the thing mentioned, and not to anything else absent or understood; thus, in the above phrase, the term "eastward" should be held to relate to the rocks, and not to the ship, just as in "clear the ship to the eastward," it relates to the ship, and not to the rocks.

It might be dangerous to force a reform too suddenly in technical expressions, however vicious; but, on the other hand, no expression can maintain its ground when proved to be wrong. In the meantime it will be proper to use a fuller form of phrase, such as "clear the M., leaving them to the westward." In the course of time, "leaving them" would be dropped, and we should have the expression in its correct form, the bearing relating to the thing mentioned.

Some ambiguity necessarily attaches to the word "pass," because it is both active and neuter; thus, "passing an island to the westward," does not altogether declare whether the ship passes to the westward or leaves the island to the westward.

It is often, in like manner, a matter of doubt whether bearings given in the description of a light relate to the light itself or to the spectator: thus, "a light obscured from N. to E." may mean either "invisible from the N.E. quarter" (that is, when *bearing* S.W.-d), or "invisible to a spectator in the S.W. quarter" (or *bearing* N.E.)

This ambiguity is removed by the same rule, which supposes the spectator always in the centre of the compass, and, therefore, that the bearing specified relates to the point mentioned. The above phrase should, therefore, be held to mean the light invisible when bearing between N and E.

TABLE 11. PLACES AT WHICH DOCKS, WET OR DRY, OR SLIPS, MAY BE FOUND, REPAIRS MADE, COALS OBTAINED, &c.

This Table has been corrected from the most recent information. For fuller details see the Admiralty Dock Book for 1890.

TABLE 12. NAVIGABLE DISTANCES.

This Table, in former editions, afforded the means of estimating approximately the length in days of passages from port to port, but steam having made the table obsolete, it has been replaced by one showing the Navigable Mercatorial Distances in Nautical Miles between the Principal Ports of the World, arranged geographically. The sailor, knowing the speed at which his vessel can be driven in fair weather and foul, also the probable force and direction of the winds and currents he is liable to meet during the voyage, will be able by Table 12 to quickly make a fair estimate of the time of arrival at the port or ports to which he may be bound.*

There is some difficulty in giving at sight the distances between ports lying in different oceans. An attempt has been made to connect the first-class ports by inserting auxiliary tables where the distances between London, Liverpool, &c., and the Chinese and Australian ports are directly given. In other cases a little addition will be necessary. Care has been taken to give prominence to the great corners or turning-points of the world, as Gibraltar, Aden, Galle, Cape Leeuwin, Pernambuco, Cape Verde, &c.

The Mediterranean tables are connected with the principal ports in both hemispheres by tables from Gibraltar and Port Said.

Required the distance between Vera Cruz and Brisbane by Cape of Good Hope; by Cape Horn; and by Suez Canal; also between Genoa and San Francisco; and Famagousta and Zanzibar.

Vera Cruz to Pernambuco	4,205	Vera Cruz to Pernambuco	4,205
Pernambuco to Cape of Good Hope	3,346	Cape Horn to ,,	3,289
Cape of Good Hope to Brisbane	6,680	Brisbane to Cape Horn	5,995
	14,231		13,489
Vera Cruz to Gibraltar	5,044	Genoa to Gibraltar	852
Gibraltar to Port Said	1,920	Gibraltar to San Francisco	12,569
Port Said to Brisbane	8,698		
	15,662		13,421
Genoa to Port Said	1,428	Famagousta to Port Said	250
Port Said to Hong Kong	6,465	Port Said and Zanzibar	3,108
Hong Kong to San Francisco	6,444		3,358
	14,337		

* It must be remembered that ships in sailing or steaming round the world, *gain a day* in their reckoning, going *East*; and *lose a day* going *West*. This alteration of date may be attended with some embarrassment if care is not taken to insure accuracy, by referring the days and hours of departure and arrival to Greenwich time by means of the Greenwich Date: *See* No. 481 and "Variation of Time at Sea," p. 354.

A short rule to estimate day and hour of arrival for steamships crossing the Pacific Ocean is: Going West: Add one day to assumed time of length of passage, and subtract the Diff. Long. *in time* between the two ports. Going East: Subtract one day from assumed time of passage, and add the Diff. Long. *in time*.

Table 13. Time Signals.

This Table shews, for all parts of the world, where the Time Signals are made from which the error of the chronometers on Greenwich Mean Time can be obtained, and by which, if the length of stay permits, they can also be rated. For more detailed information see List of Time Signals, published yearly by the Admiralty.

Table 14. Epacts of Years and Months.

The Table contains the Epacts for certain years, and for the first day of each month.

The Epact for the year is the moon's age on January 1st. The Epact for the month is her age on the first day of the month, supposing her to change on January 1st at noon.

As a mean lunation is $29^d\ 12^h\ 44^m$, the moon describes, in 365 days, twelve complete lunations, and $10^d\ 15^h$ of the thirteenth; hence, on each 1st of January her age is $10^d\ 15^h$, on the average, more than on the preceding 1st of January, and $11^d\ 15^h$ if the preceding year was leap year.

Table 15. Semi-Menstrual Inequality.

The Table contains the Semi-menstrual Inequality for the places enumerated. Its use is shewn in the examples, p. 342. The Table was constructed by combining together the several semi-menstrual inequalities of the places specified, together with a few observations at St. Helena, to which place, also, the Table therefore may be applied.*

Table 16. Rise and Fall of the Tide.

The Table shews approximately the space through which the surface of water rises or falls at given intervals from high or low water. It is entered with the said interval at the top, and the range for the day at the side.

Ex. 1. It is high water at a dock-sill at $11^h\ 20^m$ A.M., and the water is 31 ft. deep, the range is 24 ft.: find the depth at $12^h\ 15^m$. From $11^h\ 20^m$ to $12^h\ 15^m$ is 55^m (or 1^h); then under 1^h, against 24 ft., is 1·6, which is the fall of tide in 1^h, and being subtracted from 31 ft., leaves 29·4, the depth required.

Ex. 2. It is low water at $4^h\ 50^m$ P.M., and the depth is 2 ft. At a place where the range is 17 ft. find the depth at $8^h\ 30^m$. $3^h\ 40^m$ and 17 give 11·4, which, added to 2, gives 13·4, the depth required.

If the range for the day is not known, a rough estimate may be formed from the spring and neap ranges.

The Table may serve for reducing, approximately, the soundings taken at any particular time of the tide to the low-water depth. Thus, the depth 10 feet is obtained at $1^h\ 50^m$ after low water: the range between this low water and the succeeding high water is 11 feet; then $1^h\ 50^m$ and 11 give

* I am indebted for this useful table to the late Mr. Dessiou, of the Hydrog. Office, master in Her Majesty's navy, who was employed at the Admiralty in reducing the greater part of the tide observations made at our ports for many years; a task which Dr. Whewell considers, in the amount of labour and in the judgment displayed in the mode of proceeding, as not inferior to any discussion of large masses of astronomical or other observations by modern calculators, and of which some idea may be formed from the circumstance that London alone furnished 13,000 observations.

0·8, which, deducted from 10 feet, leaves 9·2 feet, the reduced low-water depth. The results are only approximate. It has been remarked, at least at some places, that the rise and fall do not correspond, and that the water falls more rapidly at first.* Care must be taken in using this Table where there is a large Diurnal Inequality (see Nos. 926–928).

To compute a Term. With the time from high or low water as a course, and the Range as dist., find the diff. lat., and subtract it from the range; the remainder is the rise or fall.

NAUTICAL ASTRONOMY.

REDUCTION OF THE ELEMENTS IN THE "NAUTICAL ALMANAC."

THESE Tables are used in the rules from p. 205 to p. 228.

TABLES 17 AND 18. ARC AND TIME.

These Tables contain the corresponding divisions of Time and Arc. Their use has been exemplified in Nos. 570 and 572.

TABLE 19. CORRECTION OF THE SUN'S DECLINATION AT NOON AT SEA, FOR LONGITUDE AND TIME.

This Table contains the correction for the sun's declination at noon, as taken out of the Naut. Alm. or Table 60, for reducing it to any other long. than that of Greenwich, or to any other hour of the day than noon. The correction is the variation of the declination, and, as it depends chiefly on the declin. itself, the declin. is employed as the argument instead of the day of the month.

The Table is entered with the declin. at the top, and the Long., or the time, at the side. See examples, No. 579.

TABLE 20. CORRECTION OF THE EQUATION OF TIME AT NOON, AT SEA, FOR LONGITUDE AND FOR TIME.

The Table is entered with the daily variation at the top, and the longitude, or the time, at the side; the correction, in the body of the Table, is in seconds of time. See the examples, No. 583.

TABLE 21. FOR REDUCING DAILY AND 12-HOURLY VARIATIONS.†

This Table shews the proportional part for each half-hour of the 24^h, or each 15^m of the 12^h, corresponding to any daily or 12-hourly variation from 1′ to 30′, or 1″ to 30″.

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* With such irregularity will also be taken that called *tide and half tide*, in some places where the fall of the water is checked about half ebb, and a temporary rise takes place, as in the superior height of the night tides in the river Columbia, observed by Sir E. Belcher.

† For the design of this very convenient table I am indebted to Capt. W Ramsay, R.N.

When the variation exceeds 30, take the parts for 30 and for the excess above 30.

Consider minutes of time above 0^m or 30^m as hours, and write the min. of the proport. part as seconds, and the seconds as thirds.

Examples are given in No. 580, and many others.

For extreme precision, the even columns (2′, 4′, &c.) only must be used, because the odd columns are often 0″·05 in defect, as are all those for 30″.

The Table serves for reducing the R.A. and Decl. of the sun and planets, the Equation of Time, the Moon's Horizontal Parallax, and Semi-diameter; and also for various other purposes, as proportioning for the rate of a watch, the drift of a current, &c.

Table 21 A. Logarithms for reducing Daily Variations.

This Table contains logarithms for reducing 24-hourly variations. Its use is described in No. 597 (2).

To compute a Term. From the const. 3·15836(the log. of 1440, the number of min. in 24^h, or of seconds in 24^m) subtract the log. of the given time or arc; read hours or degrees as min., and min. as seconds.

Ex. 1. Find the Log. for $11^h\ 28^m$.

Const.	3·1584
$11^m\ 28^s = 688^s$ log.	2·8376
Log. req.	0·3208

Ex. 2. Find the Log. for 21′ 27′

Const.	3·1584
21′ 27″ = 1287″ log.	3·1096
Log. req.	0 0488

Table 22. For reducing the Moon's Declination.

The Table is entered with the difference for 10^m (from the Naut. Alm.) at the top, and the minutes of the Greenwich Date at the side.

Ex. Green. Date, $11^h\ 27^m$, Diff. for 10^m, 136″.

27^m and 130″	5′ 51′
6	16·2
Proportional Part	6 7·2

The parts may be taken out to the seconds of the Greenwich Date by reading minutes as seconds, and seconds as thirds.

Table 23. Acceleration.

This is the change of the sun's mean Right Ascension in a mean solar day. It is employed in reducing the Sidereal Time at mean noon to the Green. Date, and in converting Mean Time into Sidereal Time.

The Acceleration is itself a portion of Sidereal Time.

Table 24. Retardation.

This is the change of the sun's mean Right Ascension in a sidereal day It is employed in converting Sidereal Time into Mean Time.

The Retardation is itself a portion of Mean Time.

For examples of the use of these two Tables, see Nos. 585, 602, &c.

Table 25. For finding the Equation of Second Differences.

The use of this Table is described in No. 599. The column headed 1^h (which may be read 1° or 1′) is adapted to all tables in which the intervals are sexagesimally divided.

To compute a term. Multiply half the difference between the Tabular Interval and the proposed Interval by the latter, and divide the product by the square of the Tabular Interval.

Ex. Tabular Interval 12^h, Proposed Interval $5^h\,40^m$, or $5^h{\cdot}7$

Tab. Int.	12^h	
Proposed	5·7	then $\frac{3{\cdot}1 \times 5{\cdot}7}{144} = 0{\cdot}1227$, the multiplier.
	6·3	
Half Diff.	3·1	

TIMES OF CERTAIN PHENOMENA.

These Tables are employed in the methods, p. 205, &c.

TABLE 26. APPARENT TIME OF THE SUN'S RISING AND SETTING.*

The Table is entered with the Latitude at the side, and the Sun's Declination, at the *top*, when these are of the *same* name; but at the *bottom* when of *contrary* names. Thus, in lat. 31° N., the sun, when in 4° S. decl., rises at $6^h\,10^m$ A.M., and sets at $5^h\,50^m$ P.M.

This is the *Civil Time* of the rising or setting of the sun's *centre*, to the eye at the level of the sea, and without the atmosphere. For greater exactness see No. 638.

To compute a Term. See Nos. 620, 621.

TABLE 27. APPROXIMATE APPARENT TIMES OF THE MERIDIAN PASSAGES OF THE PRINCIPAL FIXED STARS.

TABLE 27 A. CORRECTION OF THE TIMES IN TABLE 27.

The times are given in Table 27 for the 1st of each month, and the meridian of Greenwich. To find the time of passage for any other day, *subtract* the portion of time corresponding to the day of the month in Table 27 A from the time in Table 27. For an ex. see No. 625.

The Table is adapted to 1902, but will be within 2^m for many years.

TABLE 28. CORRECTION OF THE MOON'S MERIDIAN PASSAGE.

The Table is entered with the Daily Variation at the top, and the Longitude at the side.

The Daily Variation in W. long. is the difference between the time of the moon's transit on the given day and the next; in E. long. it is the difference between the moon's transit on the given day and the day before.

In W. long. *add* the correction to the time of meridian passage on the given day; in E. long. *subtract* it.

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* This is the apparent (not *mean*) time of the true (not the *visible*) rising or setting.

Ex. 1. May 9th, 1870, long. 51° W.: required the time of the Moon's Mer. Pass.

Mer. Pass. N.A. 9th	$7^h\ 17^m$
10th	8 9
Daily Var.	52
Corr. for 51° W.	7
	7 17
TIME req.	7 24 P.M.

Ex. 2. July 25th, 1870, long 132° E.: required the time of the Moon's Mer. Pass.

24th	$21^h\ 29^m$
23d	20 39
Daily Var.	50
Corr. for 132° E	−18
	21 29
	21 11
TIME req.	9 11 A.M.

TABLE 29. HOUR-ANGLE AND ALTITUDE OF A BODY UPON THE PRIME VERTICAL.

The Table is entered with the Declination at the top, and the Latitude (of the *same* name) at the side.

Ex. Lat. 50° and ☉'s Declin. 10°, give his Hour-Angle $5^h\ 26^m$, and Alt. 13°·2, or 13° 12'.

The alt. which, partly for space and partly for distinction, is noted to the nearest 0°·1, or 6', will not be in error on this account more than 3'. Thus the alt. 13°·1, which is properly 13° 6', may be between 13° 3' and 13° 9'; but 13° 2' is 13°·0, and 13° 10' is 13°·2. Hence, taking 13°·1 as 13° 6' cannot entail an error exceeding 3'. The error will generally be less.

This alt. being the *true* alt., the sun or a star will pass the prime vertical at an alt. *greater* than the alt. given, by the diff. between the true and obs. alts.; the moon, on the contrary, at a *lesser* alt., by this amount.

As no star of which the declin. is greater than the lat. passes the prime vertical, such cases do not appear in the table.

The Table shews at once, roughly, the effect of an error of 1° of lat. in determining the time by a single altitude in the most favourable case.

Ex Lat. 45° N., Decl. 3° N., the times are the same for 3° or 4° of latitude; that is, a gross error of lat. is of no consequence in computing the time of passage. But if the body have 23° of declin. an error of 1° of lat. will cause an error of 3^m or 4^m in that time.

By reversing the lat. and declin., the hour-angle and altitude become those of a body at its greatest elongation, or azimuth, from the pole.

To compute the Hour-angle, see No. 619. *To compute the Alt.*, see No. 665.

ALTITUDES.

These Tables are used in the rules, p. 230, &c.

TABLE 30. APPARENT DIP OF THE SEA-HORIZON.

This is the angular depression of the sea-horizon below the true level, in ordinary states of the atmosphere, and when the sea and air are of equal temperature.

The apparent dip is the true depression (Table 8), diminished by about $\frac{1}{14}$ of itself. As this correction varies with the state of the air near the horizon, altitudes taken at sea, especially low altitudes, are not to be depended on where great accuracy is required. See No. 208.

Table 31. Mean Astronomical Refraction

The Refraction is given for the barometer at 30 inches, and Fahrenheit's thermometer at 50°, according to Ivory.* The diff. to 10′ of alt. is inserted.

Ex. 1. The refraction at 20° is 2′ 39′.

Ex. 2. The refr. to the alt. 38° 35′ is 1′ 13″·3, deducting ·2, or 1′ 13″·1.

The tenths of seconds are omitted at altitudes below 35°, on account of the uncertainty at low altitudes.

To find the Refraction approximately. With the alt. as course and dep. 58, find the D. Lat.; this is the refraction in seconds. For the refr. is proport. nearly to the tang. of the zen. dist., and is 58″·2 at zen. dist. 45°

Ex. Alt. 10°, as course, and Dep. 58, give 329″, or 5′ 29″, the refr. required.

Table 32. Correction of the Mean Refraction for the Height of the Thermometer.†

The Table is entered with the Alt. at the top, and the degree of Fahrenheit's therm. at the side. When the therm. is *below* 50°, the correction is *added* to the mean refr.; when *above* 50°, it is *subtracted.*

Ex. Alt. 17° 10′, therm. 72°; the corr. is 8″, which, subtracted from the mean refr., 3′ 7″, gives the true refraction 2′ 59″.

To find the Correction, nearly. Multiply the mean refraction in seconds by 2, and by the difference between the height of the therm. and 50°, and divide the product by 1000.

Ex. Alt. 5°, therm. 38°. The mean refr. 9′ 54″, or 594″, mult. by 2 and by 12, is 14256, and this divided by 1000 gives 14″.

Table 33. Correction of the Mean Refraction for the Height of the Barometer.

The Correction is given to each tenth of an inch. The Table is entered like Table 32. When the barom. is *above* 30 inches, the correction is to be *added;* when *below*, *subtracted.*

Ex. Alt. 17° 10′, barom. 29·2 in.; the corr. is 5″, and true refr. 3′ 2′.

To find the Correction. Multiply the mean refr. in seconds by the difference between the height of the barom. and 30 inches, and divide the product by 30.

Ex. (Above.) 3′ 7″, or 187″, mult. by ·8, and divid. by 30, gives 5″.

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* The refractions now used by astronomers are those according to Bessel. Ivory's exceeds these by 0·9″ at alt. 45°, by 2″ at alt. 20°, and 5″ at alt. 10°. The difference of the tables is scarcely worth a more extended notice.

† This correction involves the term $\frac{d\delta\theta}{d\tau}(\tau-50°)$. The term $\frac{d\delta\theta}{dp}(p-30)$ is omitted as insensible.—*Phil. Trans.* 1823, p. 476.

TABLE 34. THE SUN'S PARALLAX IN ALTITUDE AND SEMIDIAMETER.

These are given for convenience on some occasions, but not for extreme precision.

To compute the Sun's Parallax in Altitude. Take the hor. par. in the Naut. Alm. as dist., and find the D. Lat. to the app. alt. as course

TABLE 35. DIP OF A SHORE-HORIZON.

The Table shews the Apparent Dip to be used instead of the dip in Table 30, when the distant sea-horizon cannot be seen, and the altitude is observed from the water-line on the beach. The distance of this line may either be estimated nearly, as it is always less than the true dip due to the height of the eye (Table 8), or it may be found by the method No. 550.

To compute a Term. Take the diff. between the depr. to the eye (Table 8) and the dist. of the beach-line, and divide by twice this last; add the quotient to the app. dip in Table 30.

TABLE 36.*

This Table contains the scales of the Centigrade and Réaumur thermometers, corresponding (approximately) with that of Fahrenheit.

The zero of the two former, or the freezing point of water, being 32° of of Fahr., and their boiling points 100° and 80° respectively, while that of Fahr. is 212°; the following rules are derived for the conversion of the scales.

To convert the Centigrade into Fahrenheit. Multiply the degrees of the Centigrade by 9, and divide the product by 5. When the Centigrade degrees are above 0, add 32° to the quotient; when *below* 0 (or marked —), subtract it from 32°.

To convert Réaumur into Fahrenheit. Multiply the degrees by 9, and divide the product by 4. Apply the quotient as directed above.

Ex. Centig. — 11·7, find Fahr. 11·7 × 9 = 1053, this ÷ 5 = 21·1, which *subtracted* from 32° gives 10°·9.

To extend the Table. For the Centigrade add 0·555, &c., and for Réaumur 0·444, &c., for each 1° of Fahr.

TABLE 37.

This Table contains the English measures corresponding to the *Mètre, Kilomètre, Décimètre,* and *Millimètre.*† See p. 380. Thus 30 centim. are 11·81 inches; 3 kilom. are 1·618 nautical miles.

The barometer scale, in English inches, and millimètres (approximately), is annexed.

To reduce the French to the English barometer scale. Divide the millimètres by 25·4, the quotient is the number of English inches required.

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* As numerous valuable works relating to Navigation are published by the French, and as other Continental nations frequently employ the language of that country in hydrographic documents, Tables 36 and 37 are added, for the ready reduction of such French measures as most frequently occur.

† The quantities are taken from the *Annuaire,* for 1846. The mètre is the 10-millionth part of the quadrant of a meridian.

When the French scale is given in inches and lines (or 12ths of an inch), multiply the inches by 1·065, the product is English inches.

To extend the barometer scale, add 2·54 millimètres for each 0·1 of an inch.

TABLE 38. CORRECTIONS OF ALTITUDE OF THE SUN AND STARS.

The Table contains the gross corr. of alt., or the corrections enumerated in No. 644, exclusive of index error, to the nearest tenth of a minute, using Bessel's Mean Refractions.

For examples, see No. 648.

TABLE 39 THE MOON'S CORRECTION OF ALTITUDE.

The Table contains the Correction to each minute of horizontal parallax and every 10′ of alt.; for the barom. 30 inches, and Fahrenheit's therm. 50°.

Ex. The corr. to app. alt. 15° 30′ and hor. par. 56′, is 50′ 31″.

For seconds of parallax. Look among the columns on the right side of the page, and against the alt., and take out the seconds, which ***add*** to the correction.

For minutes of altitude. Take the seconds from the extreme right of the page, and apply them as there directed.

Ex. Moon's App. Alt. 35° 37′, Hor. Par. 57′ 32″; find the Correction of Altitude.

35° 30′ and 57′		45′ 3″
	32″, parts 26	
7′	parts, −4	22
CORRECT. req.		45 25

To correct for the Barom. and Therm. Take the corrections from Tables 32 and 33, but apply them to the correction of alt. the *contrary way* to that directed. Ex., No. 655.

To compute a Term. Correct the app. alt. (of the centre) for refraction To the log. sec. of this alt. add the prop. log. of the horizontal parallax; the sum is the prop. log. of the parallax in alt. From this subtract the refraction; the rem. is the correction of alt.

The Table does not give the correction with precision at low alts.*

TABLE 40. CORRESPONDING HORIZONTAL PARALLAX AND SEMIDIAMETER OF THE MOON.

As these two elements are generally required together, the Table renders it necessary to reduce the parallax alone to the Greenwich Date.

TABLE 41. DIMINUTION OF THE MOON'S HORIZONTAL PARALLAX FOR THE SPHEROIDAL FIGURE OF THE EARTH.

The Table is entered with the Horizontal Parallax at the top and the Latitude at the side; the seconds corresponding are to be *subtracted* from the equatorial hor. par.

The compression employed is $\frac{1}{300}$.

* In all these tables of refraction the eye is supposed at the level of the sea; when the observer is at very great elevations, low altitudes cannot be corrected with precision by the tables in common use. The refraction is in such cases too great.

TABLE 42. AUGMENTATION OF THE MOON'S SEMIDIAMETER.

The Table is entered with the Moon's Semidiameter at the top and her Altitude at the side; the seconds corresponding are the excess by which her apparent semidiameter at her actual altitude exceeds that at which it would appear if seen from the centre of the earth. See Nos. 439 and 440.

TABLES 43 AND 44. FOR CONVERTING TRUE INTO APPARENT ALTITUDES.

These contain the further correction necessary in reducing a true to an apparent altitude, after *adding* the refraction and *subtracting* the parallax. See Nos. 657 and 658.

TABLE 45. PARALLAX OF THE PLANETS IN ALTITUDE.

The Table is entered with the Planet's Horizontal Parallax at the top, and its Altitude at the side; and the corresponding seconds taken out.

To compute a Term. Enter the Traverse Table with the alt. as course and the hor. par. as dist., and take out the D. Lat.

TABLE 46 AZIMUTH CORRESPONDING TO THE CHANGE OF ALTITUDE IN 1^m OF TIME.

The Table shews the Change of Altitude in 1^m of Time at any Azimuth in Latitudes below 66°. The azimuth is reckoned either from N. or S.

Ex. In lat. 50°, at the azim. 40°, reckoned either from N. or S., the change of alt. in 1^m is 6′ and some seconds.

The Table shews also, roughly, the true bearing when the change of alt in 1^m is given. See also No. 677.

The column of 6′ limits the azimuth for finding the time, No. 778.

LATITUDE.

THESE Tables are employed in the rules in Chap. V., p. 243.

TABLE 47. LIMITS OF THE REDUCTION TO THE MERIDIAN AT SEA.

This Table shews how long before or after noon the sun's altitude may be observed, so that the Reduction shall not be *in error* more than 2′ when the *time* is 1^m in error. The Table, therefore, shews the Limits of this method for common practice at sea.

If the time be in error, or doubtful, 2^m, 3^m, &c., the Reduction will, at the limits, be in error, or doubtful, 4′, 6′, &c. In like manner, if the error of time be less than 1^m, that of the Reduction will be less than 2′, in the same proportion.

If the time is doubtful 2^m, 3^m, &c., and we require that the error of the Reduction shall not exceed 2′, we must take for the limit ½, ⅓, &c., that set down; thus, if in lat. 48° N., decl. 10° N., the time be doubtful 3^m, we must take the alt. within ⅓ of 28^m, and that is, 9^m from noon.

When the time from noon, of observation, exceeds the limits set down, the error of the Reduction (caused by 1^m error in the time) will exceed 2′ in the same proportion; thus, in the above case, if the alt. be observed 56^m from noon, the error of 1^m in the time will cause 4′ error in the Reduction.

The time in the Table is that hour-angle, nearly, at which the number of minutes (of time) is equal to the number of minutes (of arc) in the Reduction.

To find this Hour-Angle. To the constant 0·4771, add the log. from Table 70; the sum is the prop. log. of the hour-angle required, in time.*

TABLE 48. VALUE OF THE REDUCTION AT WHICH THE SECOND REDUCTION AMOUNTS TO 1′.

The Table contains, against each Mer. Alt. under 85°, that value of the Reduction at which the 2d Reduction amounts to 1′; and therefore shews whether it is necessary or not to compute the latter.

Ex. Suppose the mer. alt. 68° and the (first) Red. computed to be 47′, then the error of omitting the 2d Red. cannot amount to 1′; but if the 1st Red. were 54′, the omission of the 2d Red. would cause an error of more than 1′.

One eighth of the quantity in this Table is that (1st) Reduction at which the 2d Red. amounts to 1″.

Thus, in Ex. No. 707, p. 252, the mer. alt. is 60°, the value of the 1st Red. in the Table is 1° 3′, 1-8th of which is 8′; hence, if the Red. exceed 8′, the 2d Red. will exceed 1″.

To compute a Term. To the constant 6·7648 (the sin. of 2′), add the log. cot. of the mer. alt.; half the sum (preserving 10 in the index) is the log. sine of the reduction required.

Ex.	Const.	6·7648
Mer. alt. 60° 50′ cot.		9·7467
		2)16·5115
RED required 1° 2′ log. sin.		8·2557

To find the time from noon, or the hour-angle, to which this (1st) Reduction corresponds: from the log. sine of the Red. subtract the log. in Table 70, the remainder is the log. sine square of the time or hour-angle required.

Ex. 1. Lat. 60° N., decl. 14° N. (mer. alt. 44°), Red. 1° 24′; 8·388 − 0·130 = 8·258, the sin. sq. of $1^h\ 1^m\ 53^s$, the hour-angle required.

Ex. 2. Lat. 29° N., decl. 17° S. (mer. alt. 44°), Red. 1° 24′, gives $0^h\ 47^m\ 3^s$.

These precepts concerning the Reductions are, of course, merely approximations near enough in practice.

TABLES 49 AND 50. FOR COMPUTING THE REDUCTION TO THE MERIDIAN IN SECONDS. *See* No. 707.

The seconds forming part of the 1st Reduction (Table 49) are taken out to the min. and sec. of the hour-angle. When the sun is observed in the forenoon, the Table is entered with the time from midnight, for convenience.

* Mr. Towson has constructed convenient tables for reducing an alt. observed near the merid. to the mer. alt., which are published by the Hydrographic Office (J. D. Potter, agent).

The seconds for the 2d Reduction (Table 50) are taken out for the hour-angle to the nearest 10^s.

To compute a Term in Table 49. To the const. 5·615455, add the log. sine square of the hour-angle; the sum is the log. of the number of seconds.

To compute a Term in Table 50. To the const. 5·6155 add twice the log. sine sq. of the hour-angle; the sum is the log. of the 2d Red.

Ex. Find the Reduction, and also the 2d Red., in seconds, for the hour-angle $28^m\ 4^s$

	Const.	5·61545		Const.	5·615
H. Ang. $28^m\ 4^s$	sin. sq.	7·57341		sin. sq. × 2	5·147
Reduct. 1544″·8	log.	3·18886	2d Red. 5″·8	log.	0·762

Table 51. Correction of the Altitude of the Pole-Star at Sea.

The Table is entered with the Altitude of the star at the top, and the Right Ascension of the Meridian at the side. The quantity taken out is to be applied to the star's true alt. as directed, ex. No. 773.

The last column contains the variation in ten years, which is always *subtractive* from the correction in the Table.

As the observation at sea is imperfect, the correction has been computed to whole minutes only.

The quantity is the D. Lat. answering to the star's hour-angle as course and 77′as dist. (the star's pol. dist. in 1890), together with a second correction computed in No. 774.*

Table 52. Reduction of the Latitude.

This is the difference between the latitude as actually found by any astronomical observation and what it would be if the earth were a sphere, which last is called the *geocentric* latitude.

To reduce the lat. by observation to the geocentric latitude, *subtract* the reduction of latitude.

This quantity, which is also called the *angle of the vertical*, is 0 at the equator and at the pole, and is greatest in lat. 45°.

The compression assumed is $\frac{1}{300}$; that is, the polar radius is supposed to be shorter than the equatorial radius by $\frac{1}{300}$ of the latter.

LONGITUDE.

These Tables are employed in the methods, Chapter VII. p. 297

Table 53. Correction of the Lunar Distance for the Contraction of the Vertical Semidiameter.

The Table is entered with the Alt. at the top and the Angle contained between a plumb-line through the body, and the line joining the other body.† See No. 852.

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* The Nautical Almanac method strongly recommended.

† The argument in this table, in the usual form, is the angle which the semidiameter in the direction of the other body makes with the *horizon*; but it is difficult to imagine the horizon where it is not, whereas the plumb-line is an absolute standard everywhere.

TABLE 54 ERROR OF OBSERVATION ARISING FROM AN ERROR IN THE PARALLELISM OF THE LINE OF SIGHT.

The Table shews the Error on any observed angle less than 120°, arising from the line of sight not being parallel to the plane of the sextant or circle. See No. 495 (3).

As the observer will not, knowingly, allow this adjustment to remain defective, or observe elsewhere than in the centre of the field when the adjustment is perfect, the Table serves rather to shew the consequence of such errors than for the purpose of applying a specific correction.

To compute a Term. To twice the log. sine of the error in the parallelism of the telescope, add the log. tan. of half the angle measured; the sum is the log. sine of the required error in the observed angle.

Ex. Error of parallelism 12', angle measured 97°: required the Error of the Angle.

12' log. sin. 7·5429	× 2	5·0858
97°, half, 48° 30'	tan.	0·0532
ERROR req. 2''·8	sine	5·1390

TABLE 55. FOR CORRECTING THE LUNAR DISTANCE FOR THE SPHEROIDAL FIGURE OF THE EARTH.

The Table is entered with the Latitude and the Moon's Altitude. The numbers are noted to the nearest 10. See No. 853.

To compute a Term. To the log sine of the red. of lat. add the log. sine of the mean horizontal parallax (in Table 40=57'), and the log. sine of the alt.; the sum is the log. sine of a small arc, which multiply by 100.

TABLE 56. FOR COMPUTING THE MOON'S *SECOND* CORRECTION OF DISTANCE.

Enter the Table with the App. Dist. at the top or bottom, and the Moon's Corr. of Alt. at the side, and take out the seconds.

In the same column take out the seconds standing against the corr. of dist. (No. 842 or 844) at the side. The difference between the two numbers thus taken out is the 2d corr. required.*

When the Dist. is *less* than 90°, *add*; when *greater*, *subtract*.

Ex. App. dist. 48°; ☽'s corr of alt. 46; corr of dist. 26': find the Second Corr.

48° and 46'	17''	
26	6	
SECOND CORR.	11	to be *added*.

To compute a Term, approximately (1.) To square an arc in minutes. Find the square of the number of min.; divide it by 60: the quotient is the number of seconds in the square required, roughly. For greater accuracy, increase the quotient by $\frac{1}{20}$ of itself.

(2.) With the app. dist. as Course, and the said square as Dep. find the D. Lat; *half* this is the term required.

* This 2d corr. may be dispensed with altogether by repeating the work, No. 844, p. 306 using the *mean* of each true and app. alt. and the *mean* of the app. and first found dist The result, with care, will agree very nearly with the rigorous process.

Ex. Corr. (of alt. or of dist.) 55′, app. dist. 31°.

55 squared (by Table 8) 3025, divided by 60	50″·4
add 1-20th	2·5
Required SQUARE of 55′	53

Dep. 53 and Course 31° give D. Lat. 88; the term is 44″.

TABLE 57. CORRECTION OF THE GREENWICH MEAN TIME FOR THE SECOND DIFFERENCE OF THE LUNAR DISTANCE.

This Table is entered at the top with the Approximate Interval, and at the side, with the Diff. of the Prop. Logs. standing against the two distances in the Nautical Almanac, which include the given true distance.

For an example, see No. 857.

To compute a Term, approximately. Multiply together the approx. interval in hours and tenths, its compl. to 3^h, the diff. of the prop. logs. above (attending to the decimal point), and 1400.

Ex. Approx. interval, $1^h\ 10^m$, diff. prop. logs. 64; then 1·2 × 1·8 × 0·0064 × 1400 = 19^s, the required term.

TABLE 58. THE ERROR OF THE SHIP'S PLACE AND OF THE LONGITUDE IN TIME, CORRESPONDING TO AN ERROR OF 1′ IN THE LUNAR DISTANCE.

The Table is entered with the Latitude at the top, and the Prop. Log. against the lunar dist. in the Nautical Almanac at the side.

Ex. Lat. 50°, prop. log. 2800; an error of 1′ in the lunar dist. will cause an error of 19 miles in the ship's place, in Departure, and $2^m\ 0^s$ ERROR OF LONG. IN TIME.

Since it is the actual distance of the ship from the shore that we are concerned with at sea, rather than the nominal diff. of long., this Table will afford a useful check on the supposed place of the ship in making the land by a lunar observation.

The error of long. in time is also the error of the G. M. Time, as determined by a lunar observation.

To compute a Term. Divide 2700 by the 3-hourly change in minutes; the quotient is the error in min. of long. in arc at the equator. For any particular latitude see No. 307

TABLES FOR DETERMINING THE VARIATION OF THE COMPASS.

These Tables are employed in Chapter VIII. p. 326.

TABLE 59. AMPLITUDES.

The Table shews the True Amplitude of the sun (or of any other celestial body, having the same declination), at rising or setting. It is entered with the Decl. at the top and the Lat. at the side.

To find the Amplitude by the Traverse Tables. With 0 and the lat.

find M. With M as Dist., and the Decl. as Course, find the Dep. With 100 as Dist. and this Dep. find the Course.

By Computation. To the log. sec. of the lat. add the log. sine of the Declin.; the sum is the log. sine of the amplitude.

Ex. Lat. 17°, Decl. 23°: find the Amplitude.

Lat.	17° 0′	sec. 0·0194
Decl.	23 0	sine 9·5919
AMPLITUDE,	24° 7′	sin. 9·6113

TABLE 59 A. CORRECTION OF THE OBSERVED AMPLITUDE.

The Table shews the Change produced on the Amplitude by the joint effect of the refraction at the horizon (assumed at 33′), and the height of the eye, supposed 16 feet. An example is given in No. 886.

To find the correction for any other height of the eye. To 33′ add the Dip, multiply the sum by the correction in the Table, and divide by 37; the quotient is the correction required.

Ex. Lat. 55°, decl. 23°, height of the eye 100 feet; 33 and 10 are 43, which, multiplied by 1·4 and then divided by 37, gives 1° 6, the CORRECTION required.

TABLES TO SUPPLY THE PLACE OF THE NAUTICAL ALMANAC.

These Tables, which afford for several years approximate values of the quantities contained in them, are useful on various occasions, and may serve for the ordinary purposes of navigation. But when much accuracy is required, and whenever the moon is employed, recourse must be had to the Nautical Almanac.

TABLE 60. DECLINATION OF THE SUN.

The Table contains the Declination for each day of the years 1901, 1902, 1903, and 1904, to the nearest minute.

TABLE 60 A. CORRECTION OF THE SUN'S DECLINATION IN TABLE 60 FOR THE YEARS FOLLOWING 1901, &c.

The Table contains the Corrections by which the declination for any day on one of the four years enumerated may be converted into that for the same day on any following year, till 1928.

When the declination is *increasing, add the correction*; when *decreasing, subtract it.*

Ex. 1. Feb. 3rd, 1914, find the Sun's declination.

1914 answers to 1902

1902, Feb. 3rd, 16° 42′ S. (decr.)

Corr. 1′·6, or −2

DECLIN. req. 16 40 S.

Ex. 2. Sept. 27th, 1920, find the Sun's declination.

1920 answers to 1904.

1904, Sept. 27th, 1° 34′ S. (incr.)

Corr. 2′ S +3

DECLIN. req. 1 37 S

If the correction when subtractive exceed the declination itself, take the less from the greater, and consider the remainder as the declination required, and of the *contrary* name to that given.

The correction is additive when the declination is increasing, and subtractive when decreasing, thus changing from one to the other at the equinoxes and solstices.

To compute this Correction for reducing approximately the declination of the sun for any year, by means of the declination for any four successive years, the following rule is given by Mackay, in his Complete Navigator.

Note the number of *fours* necessary to reduce the proposed year to one of the years in the table.

Take the difference of the declination (for the year thus found), to the given and following days. Multiply this difference by the number of fours, and divide by 33: the quotient is the correction required, in minutes.

Ex. (1. above.) 1890 reduced by fours gives 1878, the number of fours being 3.
The daily diff. of the decl. on the 3d and 4th is 18, which multiplied by 3 is 54, this divided by 33 gives about 1′·6, the corr. required to be *subtracted*.

Since, at the equinoxes the correction changes suddenly from additive to subtractive, or from *sub.* to *add*, and since applying it wrongly would cause an error of double the amount of the correction, it is advisable, in case of doubt, to find the declin. for some days before the equinox, and to subtract from it the daily variation, which at this season varies uniformly for several days.

Table 61. Sidereal Time and Right Ascension of the Sun.

The Table contains the Sidereal Time for the years 1901, 1902, 1903, and 1904, to the nearest tenth of a minute.

N.B.—The Sun's Right Ascension to the nearest tenth of a minute may be found by applying the Equation of Time in Table 62 to the Sidereal Time as there directed. See p. 209, and Note, p. 211.

Table 62. The Equation of Time.

The Table contains the Equation of Time for apparent noon for 1901, 1902, 1903, and 1904, to the nearest second. The Equation for each year will serve very well for common purposes for the 4th or 8th year afterwards. The error will be greatest from the latter end of May to the middle of July, when it may amount to 2^s or 3^s in a period of 4 years, or about 7^s in four or five such periods. Towards the beginning or end of the year the error will not much exceed 2^s or 3^s, even for a considerable number of years.

Table 63. Mean Places of the Principal Fixed Stars.

The Table contains the mean places of sixty-six stars, for the 1st of January, 1900. The mean places may be reduced for any antecedent or subsequent year by applying, as directed in the Table, the annual variation in R.A., and in declination, multiplied by the number of years exceeding 1900.

To find the place for any year prior to 1900, the variation must be applied the contrary way to that directed.

The right ascension and declination of every star change during the year. The change of right ascension is, for most of the stars in the Table, between 4^s and 6^s; that of declination between $15''$ and $40''$. Among the stars which change their right ascension least are Spica, and α Cygni, the change being between 3^s and 5^s. The stars Capella, α Pavonis, and α Triang. Austr., change their right ascension about 6^s, 7^s, and 9^s, respectively, during the year. These stars are therefore less favourable than others for finding the latitude by double altitude, or the time. The star α′ Crucis changes its declination $\frac{3}{4}$ of 1′ from one part of the year to another. The variation of the right ascension of Polaris amounts to more than 2^m; that of declination to nearly 1′. In this Table + signifies *add*, and − *subtract*.

As the variations of right ascension occupy several months, their effects would not be sensible in rating a chronometer by the method, No. 821.

As the stars are given in this Table for the purpose of finding the latitude or time in different parts of the world at any hour of the night, they are selected nearly equally from all parts of the heavens, and the list does not necessarily include all stars above, or exclude all stars below, any particular magnitude,

The figures 1, 2, 3, indicate the first (or largest), second, and third magnitudes. The figures 1, 2, denote a magnitude between the 1st and 2d: and the figures 2, 3, a magnitude intermediate between the 2d and 3d.*

LOGARITHMS

These Tables are used in those parts of the several computations which are effected by logarithms. The more general tables stand first, and the others follow nearly in the order already observed.

Table 64. Logarithms of Numbers.

The Table contains the logs. of numbers from 1 to 9999, to six places, with differences and proportional parts.

The diff. D. is the mean of the diffs. between each log. and the succeeding one in the same line; and is near enough for most cases.

I. *Direct process;* to find the logarithm of a given number.

1. To find the logarithm to any number consisting of two or three figures. Look for the number at the side, and take out the log. against it. Thus, the log. of 717 is 855519.†

2. To find the logarithm of a number consisting of four figures. Look for the three first figures at the side, and the fourth at the top; thus, the log. of 7176 is 855882.

3. To find the logarithm of a number consisting of more than four figures. Find the log. of the first four figures; find the diff. D. in the lower part of the Table, in column D, and against it, under the 5th figure (or 6th, if required), are the parts, which add.

Note.—Observe to set down the parts correctly, carrying those for the 6th figure one place to the right of the parts above them, as a mistake frequently occurs here.

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* Sir John Herschel having, soon after the appearance of this work, favoured me with a communication respecting the magnitudes or relative brilliancy of the stars, to which that distinguished astronomer has paid particular attention, I have altered the numbers marked against several of the stars in the first edition.

† This, however, is only part of the complete logarithm, as adapted to the purposes of computation by logarithms, and requires the *index*. See Nos. 57 and 58.

Ex. 1. (*Five* figs.) Find the log. of 26574.

2657 log.	424392	D. 164
Against D. 164, under 4	66	
Log. req.	424458	

Ex. 2. (*Six* figs.) Find the log. of 265748.

2657 log.	424392	D. 164
4 (parts 66)	66	
8 (parts 131 ÷ 10)	13	
Log. req.	424471	

II. *Inverse Process;* to find the number corresponding to a given log

1. When the natural number is not required to consist of more than four figures, it is taken out at once.

Ex. Given the log. 645820, required the natural number.

The nearest log. in the Table is 645815; the figures at the side are 442, annexing to which that at the top, or 4, gives 4424, the NUMBER required.

The placing of the decimal point is directed in No. 59.

2. When the Number is to consist of *five* figures. Take out the next less log. to the one given, and note down the four figures of the corresponding number. Note the diff. D.

Subtract this next less log. from the given one, and look for the remainder among the parts standing against D, in the lower part of the Table; note the figure at the top under which the remainder is found, and add it to the four taken out.

3. When the Number is to consist of *six* figures, the more direct and accurate method is to take the diff. between the given log. and the next less in the Table, annex 2 ciphers, and divide by the diff. between the next less and the next greater: the quotient is the number of figures to be annexed to the natural number, answering to the *next less* log.

The placing of the decimal point is directed in No. 59.

Ex. 1. (*Five* figs.) Find the No. to the log. 424471.

Given	424471	
Next less (2657)	424392	D. 164
Rem.	79	
5th fig. 4, next less	66	
Numb. req.	26574	

Ex. 2 (*Six* figs.) Find the No. to the log. 424471.

Given log.	424471	
Next less (2657)	424392	79
Next greater	424555	163

Then 7900 ÷ by 163, gives 48, and the numb. req. is 265748.

Table 64a.

Spheroidal Tables; showing the length in feet of a degree, minute, and second of lat. and long.; the corresponding number of statute miles in every even degree of lat.; and number of nautical miles contained in a degree of long. under each even degree of lat.

Table 65. Natural Sines, Cosines, &c.

These quantities are convenient for working problems such as that given in No. 254.

Table 66. Log. Sines of Small Arcs to each Second.

The Table contains the log. sines from 0 to 1° 30′ (or log. cosines from 88° 30′ to 90°), to each second. Five places are given as far as 1° and six beyond. The Table is applicable to log. tangents, thus: to find the log. tan. add the log. sec. to the log. sine; to find the arc to a given log. tan., find it as for a sine, subtract from the given log. the log. sec., and consider the rem. as a sine

For 10ths of seconds proceed by proportion, or, in very small arcs, as directed for proportional logarithms. The last method is true in the 5th place for arcs under 5′.

Table 67 Log. Sines of Small Arcs to Ten Seconds.

The Table contains the log. sines from 1° 30′ to 4° 30′ (or the log cosines from 85° 30′ to 88° 30′), to each 10″, with parts for single seconds.

The parts are true for each 2′ and 7′ in the units' place of the arc, and very nearly for others, as the parts under 32′ serve from 1° 30′ to 1° 35′, and those under 37′, from 1° 35′ to 1° 39′. The error of using one column for the next will rarely amount to half a second.

The parts for the log. cos. are to be taken as for the sine of the compl. of the arc; thus, the parts for cos. of 87° 42′, being those for sine of 2° 17′ are found under 17′.

Direct Process. Find the sine or cos. for the next less 10″, *add* the parts for the sine, *subtract* those for the cosine.

Ex. 1. The log. sine of 2° 22 37″ is 8·617417 for 2° 22′ 30″, ***adding*** the parts under 12′ for 7″, or 356, which gives 8·617773. The log. cos. of 87° 46′ 14″ is 8·590181 for 87° 46′ 10″, *deducting* 218 (the parts for 4″ under 12′), or 8·589963.

Inverse Process. For the sine look for the next less; for the cosine look for the next greater; note the deg., min., and 10″.

Take the diff. between the sine or cos. taken out and the given one; look for it in the col. of parts; take out the corresponding seconds and add them.

Ex. 1. Find the arc to the log. sine 8·508462.

		Given	8·508462
Arc	1° 50′ 50″	Next less	8·508321
	2	Pts. at 32′	141
Arc req.	1 50 52		

Ex. 2. Find the arc to the log. cosine 8·758561.

		Given	8·758561
Arc	86° 42′ 40″	Next gr.	8·758688
	3	Pts. at 17′	127
Arc req.	86° 42 43		

For extreme precision proceed by proportion.

The Table is used for tangents by the rules in expl. Table 66.

Table 68. Logarithmic Sines, Cosines, Tangents, Cotangents, Secants, and Cosecants.

The Table contains the terms to half-minutes, and to six places.

The second column and the last but one contain a time scale, corresponding to the upper and lower degree; thus 73° 33′ 30″ corresponds to $4^h\ 54^m\ 14^s$. This scale is very convenient for converting arc and time, but it is introduced to suit those rules in which the time itself is an argument.

The parts for each second are given, beyond 9°; from 4° to 9°, to each 10″; but under 4° the variation is too rapid for their insertion, and recourse will be had for precision to Tables 66 and 67.* The parts are true for the ***middle*** term of the argument; thus, the parts from 20° 30′ to 20° 45′, are true for 20° 37′½, and approximate for the rest, but the inaccuracy in the extreme case corresponds only to ⅓ of 1″.

It is, of course, the more correct way to take the parts with reference to the *nearest* term, and to apply them accordingly; thus, to find the sine of 9° 40′ 28″, find it for 9° 40′ 30″, and *subtract* the parts for 2″.

* The diff. D., in the early portion (inserted merely for uniformity), is not that of two consecutive terms, but corresponds to ***half*** the tabular interval on ***both*** sides of a term. This is done to avoid breaking the continuity of the horizontal lines, which must occur when actual diffs. are exhibited, and is teasing to the eye.

For greater accuracy proceed by proportion.

Direct Process. When the given angle is less than 45°, its log sine, &c. are taken from the top; when greater than 45°, from the bottom; thus, the log. sine of 28° 17′ is 9·675624; the log. sine of 84° 3′ is 9·997654. In like manner, the log. sine 9·452060 corresponds to the arc 16° 27′, the cotangent 9·47714 to the arc 73° 18′.

The log. sine of an angle is the log. cosine of the complement of the angle to 90°, whether in excess or defect; so, likewise, the log. cosine is the log. sine of the complement; and the like holds of the tangent and cotangent, secant and cosecant.

When the given angle exceeds 90°, find the log. sine, tangent, or secant, for the supplement to 180°. But it is generally easier to find the log. *co*-sine, *co*-tangent, and *co*-secant, for the *excess* above 90°.

Ex. 1. The log. sine of 127° 50′ is the log. sine of 52° 10′, or the log. cos. of 37° 50′, which is 9·897516.

Ex. 2. The log. cos. of 163° 49′ is the log. cos. of 16° 11′, or the log. sine of 73° 49′, which is 9·982441.

Ex. 3. The log. cosec. of 97° 4′ is the log. cosec. of 82° 56′, or the log. sec. of 7° 4′, which is 0·003312.

In like manner to find the log. *co*-sine, *co*-tangent, or *co*-secant, of an arc above 90°, take out the log. sine, tangent, or secant, of the excess above 90°.

To find the log. sine, &c. of an arc given to seconds. Find the log. sine (or cosine, &c.) for the next less minute or half-minute; take out the part for the seconds, or for the excess above 30″.

For the sine, tangent, and secant, *add* the parts.

For the *co*-sine, *co*-tangent, and *co*-secant, *subtract* them.

Ex. 1. Find the log. sine of 53° 25′ 13″.

53° 25′ 0″ sine	9·904711
13 parts	+ 20
Log. sine req.	9·904731

Ex. 2. Find the log. tan. of 11° 19′ 54″.

11° 19′ 30″ tan.	9·301624
24 parts	+ 262
Log. tan. req.	9·301886

Ex. 3. Find the log. sec. of 38° 42′ 46″.

38° 42′ 30″	0·107716
16 parts	+ 27
Log. sec. req.	0·107743

Ex. 4. Find the log. cosine of 72° 10′ 45″.

72° 10′ 30″	9·485879
15 parts	− 98
Log. cos. req.	9·485781

Ex. 5. Find the log. cotang. of 84° 3′ 22″.

84° 3′ 0″ cot.	9·017959
20 parts 408 } 2 41 }	− 449
Log. cotang. req.	9·017510

Ex. 6. Find the log. cosec. of 68 14′ 11″.

68° 14′ 0″ cosec.	0·032124
11 parts	− 9
Log. cosec. req.	0·032115

In working to five places, the last figure of the parts must be dropped, the remainder being increased by 1 when the figure dropped exceeds 5.

In working to 1ˢ of time, the parts for 15″ are to be employed. In the earlier part of the Table, *half* the D. for 30″ may be conveniently employed.

It is convenient in dealing with parts of contrary application, to mark those *additive* with +, and *subtractive* with −; to sum each kind separately; and to take the diff. of the two sums, marking it with the sign of the greater. An example will be found, p. 264, top, the parts are, + 18, + 5, − 97, and + 35; the sum of the + ones is + 58, then the difference between 58 and 97 is 39, to be marked − 39, or subtractive.

Inverse Process. To find the Arc, to seconds, corresponding to a given log sine &c.:

For the sine, tangent, or secant, take out the next *less*; for the *co*-sine, *co*-tangent, or *co*-secant, take out the next *greater*; and note the degree and minute, or half-minute, of the quantity thus taken out.

Take the diff. between this quantity and the given one; find the remainder in the column of Parts; take out the seconds corresponding and add them to the arc noted.

Ex. 1. Find the arc to the log. sine 9·202470.

	Given	9·202470
9° 10′ 0″	Next less	202234
18	Rem.	236
Arc req. 9 10 18		

Ex. 2. Find the arc to the log. cosine 9·897796.

	Given	9·897796
37° 47′ 0″	Next gr.	897810
8	Rem.	14
Arc. req. 37 47 8		

When the parts are not given for seconds beyond 10 (as for the log. sine and tang. from 4° to 8°), if the remainder exceeds the parts given, take away the parts for 10″ or 20″; add 10″ or 20″ accordingly, and also the seconds corresponding to this last remainder.

Ex. 1. Find the arc to the log. tangent 9·127945.

	Given	9·127945
7° 38′ 30″	Next less	127651
		294
10	Parts	160
8	Rem.	134
Arc req. 7 38 48		

Ex. 2. Find the arc to the log. cosec. 10·881005.

	Given	10·881005
7° 33′ 0″	Next gr.	881433
		428
20	Parts	318
7	Rem.	110
Arc req. 7 33 27		

When greater precision than that afforded by the parts is required, the log. sine, &c., or the arc, may be found by means of the proportional part of the diff. between two terms, or for 30″.

The log. cosec. is the arith. compl. of the log. sine.

The log. cotan. is the ar. co. of the log. tan.

The log. sec. is the ar. co. of the log. cosine.

The log. tan. is the sum of the log. sine and log. secant; thus all may be obtained from the log. sine.

Table 69. Log. Sine Square.*

The title is an abbreviation of *the logarithm of the square of the sine of half the arc.* The log. sine square is given to each 15″ of arc or 1ˢ of time. In order to lessen the bulk of the table, the index, and one or two figures, are taken up at the head of the column, unless these figures change, when the whole is given in full. Five places only are inserted as far as $0^h\ 44^m$, and six afterwards.

Each column contains 15′, or 1^m; the minutes and quarters (of arc), above the next less 15′, are given on the left-hand side, and the seconds of time on the right. Thus the log. sine square of 143° 37′ 15″, or 9·955474, is found under 143° 30′ and against 7′ 15″, and corresponds to $9^h\ 34^m\ 29^s$

The parts for seconds, when not the same for the whole page, are given for the first and last columns; parts for intermediate columns are therefore between the given parts.

1. *Direct Process.* To find the log. sine square of an arc to the *nearest second.* Take the log. sin. sq. for the next less 15″, and add the parts for the seconds.

To find the log. sine square for the *tenth of a second of time.* Consider

* This table is identical with the Log. Haversines of Inman's Tables.

the tenths as seconds of arc, take out the parts, increase them by half, and add the sum to the log. sine square of the whole second.

Ex. 1. Find the log. sine square of 38° 11′ 22″		Ex. 2. Find the log. sine square of 3ʰ 42ᵐ 57ˢ·3.	
38° 11′ 15″	9·029400	3ʰ 42ᵐ 57ˢ	9·339466
7 parts	43	parts to 3″, 12, 12 + 6 =	18
LOG. SIN. SQ. req.	9·029443	LOG. SIN. SQ. req.	9·339484

The log. sine square to seconds in the early part of the Table, where, on account of the great and irregular variation, no parts are given, is found by proportion.

Ex. Find the log. sine square of 1° 36′ 4″.

1° 36′ 0″	6·28991	Then 15 : 226 :: 4 : 60, the parts, and the LOG. SINE SQUARE required is 6·29051.
1 36 15	29217	
diff.	226	

2. *Inverse Process.* To find the arc, to 1′, corresponding to a given log. sine square. From the given log. sine square subtract the next less in the Table, to which take out the arc, noting it down.

Find the seconds at the bottom corresponding to the difference, and add them to the arc.

Ex. Find the arc, to 1″, corresponding to 9·029443.

Next less 9·029400, arc 38° 11′ 15″		43 at D. 90 gives 7″, which added to 38 11′ 15″ give the ARC required, 38° 11′ 22″.
given	·029443	
diff.	43	

To find the time, to the tenth of a second, corresponding to a given log. sine square.

Find the time corresponding to the next less log. sine square in the table. Take the diff. between the given and the next less logs. Find this diff. among the parts; take out the seconds of arc corresponding, and subtract from it 1–3d of itself. The rem. is the number of tenths, to be added to the time of the next less.

The above is correct enough for common practice, but for greater precision the difference between two terms must be employed, and the result deduced by proportion.

To compute a Term. Take the log. sine of half the arc and double it.

TABLE 70. LOGARITHMS FOR COMPUTING THE REDUCTION TO THE MERIDIAN AT SEA.

The Table is entered with the Declination at the top and the Latitude at the side. The cases omitted are not eligible. See No. 700.

The cases which appear above the vacant spaces in Part I. are those in which the body passes the meridian between the pole and the zenith; those below the spaces are the more common cases, or those which occur between the tropics and the arctic circles.

To compute a Term. Add together 0·30103, the log. cosines of the lat. and decl., and the log. sec. of the meridian altitude.

The process of computing the meridian alt. may be avoided thus: when the lat. and decl. are of the *same* name, employ the log. cosec. of their *difference* (unless the body is below the pole, when employ the cosec. of their sum), when of *contrary* names, the cosec. of their *sum*.

Ex. 1. (*Same* name.) Lat. 9° N., Decl. 17° N.

			0·3010
Lat.	9°	cos.	9·9946
Decl.	17	cos.	9·9806
Diff.	8	cosec.	0·8564
Log. required			1·1326

Ex. 2. (*Contrary* names.) Lat. 9° N., Decl. 17° S.

			0·3010
Lat.	9°	cos.	9·9946
Decl.	17	cos.	9·9806
Sum	26	cosec.	0·3582
Log. required			0·6344

When the lat. exceeds 62° or the decl. exceeds 23°, the logarithm must be computed.

Table 71. Logarithms for computing the Correction of the Latitude by Account.

The Table is entered with the two Azimuths, either of the same body at different times, or of two different bodies. See No. 752 (7).

The cases omitted are not eligible.

Part I. is used when both altitudes are taken on the *same* side both of the meridian and prime vertical, and Part II. when on *different* sides of either of these circles.

To compute the Log. for Part I. To 8·8239 add the log. cosecants of the azimuths, and the log. sine of their *difference*.

For Part II. To 8·8239 add the log. cosecants of the azimuths, and the log. sine of their *sum*.

Ex. 1. Azimuths S. 70° W. and S. 11 W. (or *same* side).

			8·8239
Az.	70°	cosec.	0·0270
Az.	11	cosec.	0·7194
Diff.	59	sin.	9·9331
Log. required			9·5034

Ex. 2. Azimuths S. 70° W. and S 11° E., or N. 70° W. and S. 11° W. (or *different* sides).

			8·8239
Az.	70°	cosec.	0·0270
Az.	11	cosec.	0·7194
Sum	81	sin.	9·9946
Log. required			9·5649

Table 72. Logarithms for computing the Equation of Equal Altitudes.

These are given to each 10^m. See No. 806 (4).

To compute Log. A To 3·28534 add the log. of the interval (in seconds of time), and the log. cosec. of half the interval; take the arith. compl. of the sum.

To compute Log. B. To 3·28534 add the log. of the interval (in seconds), and the log. cot. of half the interval; take the arith. compl. of the sum.

Ex. Interval 4^h 30^m. Compute the logs. A. and B.

		3·28534
4^h 30^m = 16200^s	log.	4·20951
2 15	cosec.	0·25526
		7·75011
	Log. A.	2·24990

		3·28534
		4·20951
2^h 15^m	cot	0·17511
		7·66996
Log. B.		2·3300

Table 73. The Logarithmic Difference

This quantity is given for Fahrenheit's thermometer at 50°, and the Barometer at 30 inches.

The Table is entered like Table 39. The parts for ″ of parallax and for ′ of alt. are applied as directed in the Table.

The parts for the sun's or star's alt. are given at the bottom.

To correct the log. diff. for any other height of the thermometer and barometer than those given in the Table. Find the correction of the mean refraction for each body by Tables 32 and 33.

With the moon's alt. and her atmospherical correction, thus found, as seconds of parallax, take out the parts.

With the sun's (or star's) alt. as the moon's alt., and his atmospher. corr. as seconds of parallax, take out the parts.

When the atmospherical correction is +, *add* the parts to the mean or ordinary log. diff.; when —, *subtract* them.

Ex. (Mean state.) ☽'s app. alt. 27° 18'; Cor. par. 60' 42"; ☉'s alt. 10° 20'.

27° 10' and 60'		9·996721
8' parts	−17	
42"	−42	
☉ 10°	− 8	−67
Required Log. diff.		9·996654

Ex. The same corrected for bar. 29·2, and therm. 84°.

Mean log. diff.			9·996721
		pts. −67	
☽ Th. 84°	−8"		
Bar. 29·2	−3		
☽ Atmos. corr.	−11	−11	
☉ Th. 84°	−20		
Bar. 29·2	−9		
☉ Atmos. corr.	−29	−11	−89
Log. diff.			9·996632

When a planet is employed, consider it as a star, and its horizontal parallax as seconds of moon's parallax. With its alt. take out the parts and *subtract* them.

To compute the Log. Diff. Add together the log. secants of the app. alts., and the log. cosines of the true alts.; the sum is the log. diff.

Ex. ☽ A. Alt. 27° 18', Hor. Par. 60' 42". ☉ A. Alt. 10° 20': required the Log. Diff. for the mean state of the atmosphere, as also for the therm. 84°, and barom. 29·2 in.

Mean State.

☽ 27°	18'	0"	sec.	0·051285
	+52	5		
28	10	5	cos.	9·945255
☉ 10	20	0	sec.	0·007102
	−5	2		
10	14	58	cos.	9·993014
			Log. diff.	9·996656

Corrected for Therm. and Barom.

☽ 27°	18'	0"	sec.	0·051285
	+52	16		
28	10	16	cos.	9·945243
☉ 10	20	0	sec.	0·007102
	−4	33		
10	15	27	cos.	9·993003
			Log. diff.	9·996633

The results by the two methods agree as nearly as can be expected from processes in which each of the several parts employed has its own particular inaccuracy.

Table 74. Proportional Logarithms.

These logarithms are given to every second of time, or arc, for 3^h or 3°. The Table is entered with the hour or degree and the minute at the top, and the second at the side; thus the prop. log. of 1° 2' 27" or of $1^h\ 2^m\ 27^s$ is 4597, that of $1^m\ 2^s$ is 2·2410. The index 0 proper to quantities above 19^m (or 19') is suppressed for convenience.

To find the prop. log. of an arc under 18', to the tenth of a second. Put the proper index, and find the decimal part due to ten times the arc.

Ex. Find the prop. log. of 7' 13"·7; the index of 7' 13" is 1; the dec. part of the log due to 70' 137", or 72' 17", is 3962, the prop. log. required is 1·3962.

So the prop. log. of an arc, under 1' 48" may be found to the hundredth of a second by multiplying by 100.

To find the arc or time to the *tenth* of a second to a given prop. log. exceeding 1·0000. Look in the Table till the decimal part again occurs, and divide the arc by 10.

Ex. Find the time to the prop. log. 2·5106. Look for 1·5106; the nearest found is 1·5110, against $5^m\ 33^s$, or 333^s; hence the time required is $33^s·3$.

Four places are enough for common purposes; but since the fourth place ceases to change by 1 after $1^h\ 13^m$, a greater time than this cannot be found truly to 1^s. So also, a time exceeding $2^h\ 25^m$ cannot be found truly to 2^s. This defect may be avoided in some cases by employing the complement of the interval to 3^h.

To convert a given log. sine of an arc less than 1° 30′ into a prop. log. add 8·7190 to its arithmetical complement. To convert a prop. log. of an arc into a log. sine, less than $1'\frac{1}{2}$, add 8·7190 to its arith. compl.

Ex. 1. Convert the log. sine 8·3507 into a prop. log.

	log. sine	8·3507
	ar. co.	1·6493
	const.	8·7190
Arc 1° 17′ 5″	Prop. log.	0·3683

Ex. 2. Convert the prop. log. of 0° 25′ 0″, or 8573, into a log. sine.

pr. log.	0·8573
ar. co.	9·1427
	8·7190
Log. sine	7·8617

When the terms of an analogy are all sexigesimals, the rules given in p. 20, Nos. 64, &c., apply to the proportional logarithms; but if two of the terms are not sexigesimals, the arith. complements of the logs. of these last must be used.*

To compute a Prop. Log. From 4·03342 (the log. of 10800, the number of seconds in 3^h or 3°) subtract the log. of the given time or arc in seconds: the result is the prop. log. required.

Ex. Find the prop. log. of $2^h\ 11^m\ 28^s$.

	const.	4·03342
$2^h\ 11^m\ 28^s = 7888^s$,	log.	3·89697
	Prop. log.	0·13645

The Tables close with the Abbreviations adopted in the Admiralty Charts, with explanatory notes. These should be committed to memory by sailors.

* The proportional logarithms are often convenient, but they might be replaced with advantage by common logarithms. The prop. logs., unlike the common logarithms, continually *decrease* instead of *increasing* with the argument. This progression is always repugnant to the mind, and should be avoided when the change involves no sacrifice. Again, these logarithms require every factor with which they are combined to be inverted, that is, for ex., instead of multiplying by 2, they oblige us to divide by 2. This, even to an expert computer, is the cause of perpetual mistakes in the changing of constants; but to a beginner it has the mischievous effect of entirely destroying, in processes which may nevertheless be identical, every vestige of analogy.

If common logarithms, with the same scale and the index prefixed, were employed, the logarithm attached, in the Nautical Almanac, to the lunar distance, would involve the constant for 3^h. Such logarithms would answer all the present purposes without being open to any of the above objections; the log. in the Nautical Almanac would then be additive instead of subtractive. The proportional logarithms, originally computed for the purpose of simplifying a single step in a single computation, are an example of the ill effects of sacrificing general utility to a partial end; and the substitution of others, at a favourable opportunity, is recommended as a reform deserving attention.

TABLES.

TRAVERSE TABLE TO DEGREES

1° — 0h 4m

Dist.	D.Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	1·0	0·0	61	61·0	1·1	121	121·0	2·1	181	181·0	3·2	241	241·0	4·2
2	2·0	0·0	62	62·0	1·1	122	122·0	2·1	182	182·0	3·2	242	242·0	4·2
3	3·0	0·1	63	63·0	1·1	123	123·0	2·1	183	183·0	3·2	243	243·0	4·2
4	4·0	0·1	64	64·0	1·1	124	124·0	2·2	184	184·0	3·2	244	244·0	4·3
5	5·0	0·1	65	65·0	1·1	125	125·0	2·2	185	185·0	3·2	245	245·0	4·3
6	6·0	0·1	66	66·0	1·2	126	126·0	2·2	186	186·0	3·2	246	246·0	4·3
7	7·0	0·1	67	67·0	1·2	127	127·0	2·2	187	187·0	3·3	247	247·0	4·3
8	8·0	0·1	68	68·0	1·2	128	128·0	2·2	188	188·0	3·3	248	248·0	4·3
9	9·0	0·2	69	69·0	1·2	129	129·0	2·3	189	189·0	3·3	249	249·0	4·3
10	10·0	0·2	70	70·0	1·2	130	130·0	2·3	190	190·0	3·3	250	250·0	4·4
11	11·0	0·2	71	71·0	1·2	131	131·0	2·3	191	191·0	3·3	251	251·0	4·4
12	12·0	0·2	72	72·0	1·3	132	132·0	2·3	192	192·0	3·4	252	252·0	4·4
13	13·0	0·2	73	73·0	1·3	133	133·0	2·3	193	193·0	3·4	253	253·0	4·4
14	14·0	0·2	74	74·0	1·3	134	134·0	2·3	194	194·0	3·4	254	254·0	4·4
15	15·0	0·3	75	75·0	1·3	135	135·0	2·4	195	195·0	3·4	255	255·0	4·5
16	16·0	0·3	76	76·0	1·3	136	136·0	2·4	196	196·0	3·4	256	256·0	4·5
17	17·0	0·3	77	77·0	1·3	137	137·0	2·4	197	197·0	3·4	257	257·0	4·5
18	18·0	0·3	78	78·0	1·4	138	138·0	2·4	198	198·0	3·5	258	258·0	4·5
19	19·0	0·3	79	79·0	1·4	139	139·0	2·4	199	199·0	3·5	259	259·0	4·5
20	20·0	0·3	80	80·0	1·4	140	140·0	2·4	200	200·0	3·5	260	260·0	4·5
21	21·0	0·4	81	81·0	1·4	141	141·0	2·5	201	201·0	3·5	261	261·0	4·6
22	22·0	0·4	82	82·0	1·4	142	142·0	2·5	202	202·0	3·5	262	262·0	4·6
23	23·0	0·4	83	83·0	1·4	143	143·0	2·5	203	203·0	3·5	263	263·0	4·6
24	24·0	0·4	84	84·0	1·5	144	144·0	2·5	204	204·0	3·6	264	264·0	4·6
25	25·0	0·4	85	85·0	1·5	145	145·0	2·5	205	205·0	3·6	265	265·0	4·6
26	26·0	0·5	86	86·0	1·5	146	146·0	2·5	206	206·0	3·6	266	266·0	4·6
27	27·0	0·5	87	87·0	1·5	147	147·0	2·6	207	207·0	3·6	267	267·0	4·7
28	28·0	0·5	88	88·0	1·5	148	148·0	2·6	208	208·0	3·6	268	268·0	4·7
29	29·0	0·5	89	89·0	1·6	149	149·0	2·6	209	209·0	3·6	269	269·0	4·7
30	30·0	0·5	90	90·0	1·6	150	150·0	2·6	210	210·0	3·7	270	270·0	4·7
31	31·0	0·5	91	91·0	1·6	151	151·0	2·6	211	211·0	3·7	271	271·0	4·7
32	32·0	0·6	92	92·0	1·6	152	152·0	2·7	212	212·0	3·7	272	272·0	4·7
33	33·0	0·6	93	93·0	1·6	153	153·0	2·7	213	213·0	3·7	273	273·0	4·8
34	34·0	0·6	94	94·0	1·6	154	154·0	2·7	214	214·0	3·7	274	274·0	4·8
35	35·0	0·6	95	95·0	1·7	155	155·0	2·7	215	215·0	3·8	275	275·0	4·8
36	36·0	0·6	96	96·0	1·7	156	156·0	2·7	216	216·0	3·8	276	276·0	4·8
37	37·0	0·6	97	97·0	1·7	157	157·0	2·7	217	217·0	3·8	277	277·0	4·8
38	38·0	0·7	98	98·0	1·7	158	158·0	2·8	218	218·0	3·8	278	278·0	4·9
39	39·0	0·7	99	99·0	1·7	159	159·0	2·8	219	219·0	3·8	279	279·0	4·9
40	40·0	0·7	100	100·0	1·7	160	160·0	2·8	220	220·0	3·8	280	280·0	4·9
41	41·0	0·7	101	101·0	1·8	161	161·0	2·8	221	221·0	3·9	281	281·0	4·9
42	42·0	0·7	102	102·0	1·8	162	162·0	2·8	222	222·0	3·9	282	282·0	4·9
43	43·0	0·8	103	103·0	1·8	163	163·0	2·8	223	223·0	3·9	283	283·0	4·9
44	44·0	0·8	104	104·0	1·8	164	164·0	2·9	224	224·0	3·9	284	284·0	5·0
45	45·0	0·8	105	105·0	1·8	165	165·0	2·9	225	225·0	3·9	285	285·0	5·0
46	46·0	0·8	106	106·0	1·8	166	166·0	2·9	226	226·0	3·9	286	286·0	5·0
47	47·0	0·8	107	107·0	1·9	167	167·0	2·9	227	227·0	4·0	287	287·0	5·0
48	48·0	0·8	108	108·0	1·9	168	168·0	2·9	228	228·0	4·0	288	288·0	5·0
49	49·0	0·9	109	109·0	1·9	169	169·0	2·9	229	229·0	4·0	289	289·0	5·0
50	50·0	0·9	110	110·0	1·9	170	170·0	3·0	230	230·0	4·0	290	290·0	5·1
51	51·0	0·9	111	111·0	1·9	171	171·0	3·0	231	231·0	4·0	291	291·0	5·1
52	52·0	0·9	112	112·0	2·0	172	172·0	3·0	232	232·0	4·0	292	292·0	5·1
53	53·0	0·9	113	113·0	2·0	173	173·0	3·0	233	233·0	4·1	293	293·0	5·1
54	54·0	0·9	114	114·0	2·0	174	174·0	3·0	234	234·0	4·1	294	294·0	5·1
55	55·0	1·0	115	115·0	2·0	175	175·0	3·1	235	235·0	4·1	295	295·0	5·1
56	56·0	1·0	116	116·0	2·0	176	176·0	3·1	236	236·0	4·1	296	296·0	5·2
57	57·0	1·0	117	117·0	2·0	177	177·0	3·1	237	237·0	4·1	297	297·0	5·2
58	58·0	1·0	118	118·0	2·1	178	178·0	3·1	238	238·0	4·2	298	298·0	5·2
59	59·0	1·0	119	119·0	2·1	179	179·0	3·1	239	239·0	4·2	299	299·0	5·2
60	60·0	1·0	120	120·0	2·1	180	180·0	3·1	240	240·0	4·2	300	300·0	5·2
Dist.	Dep.	D.Lat.	Dist.	Dep.	D.Lat.	Dist.	Dep.	D.Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

89° — 5h 56m

TRAVERSE TABLE TO DEGREES

1° 0h 4m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	301·0	5·3	361	360·9	6·3	421	420·9	7·3	481	480·9	8·4	541	540·9	9·5
302	302·0	5·3	362	361·9	6·3	422	421·9	7·4	482	481·9	8·4	542	541·9	9·5
303	303·0	5·3	363	362·9	6·3	423	422·9	7·4	483	482·9	8·5	543	542·9	9·5
304	304·0	5·3	364	363·9	6·4	424	423·9	7·4	484	483·9	8·5	544	543·9	9·5
305	305·0	5·3	365	364·9	6·4	425	424·9	7·4	485	484·9	8·5	545	544·9	9·5
306	306·0	5·3	366	365·9	6·4	426	425·9	7·4	486	485·9	8·5	546	545·9	9·5
307	307·0	5·4	367	366·9	6·4	427	426·9	7·4	487	486·9	8·5	547	546·9	9·6
308	308·0	5·4	368	367·9	6·4	428	427·9	7·5	488	487·9	8·6	548	547·9	9·6
309	309·0	5·4	369	368·9	6·4	429	428·9	7·5	489	488·9	8·6	549	548·9	9·6
310	310·0	5·4	370	369·9	6·5	430	429·9	7·5	490	489·9	8·6	550	549·9	9·6
311	311·0	5·4	371	370·9	6·5	431	430·9	7·5	491	490·9	8·6	551	550·9	9·6
312	312·0	5·4	372	371·9	6·5	432	431·9	7·5	492	491·9	8·6	552	551·9	9·6
313	313·0	5·5	373	372·9	6·5	433	432·9	7·5	493	492·9	8·7	553	552·9	9·7
314	314·0	5·5	374	373·9	6·5	434	433·9	7·6	494	493·9	8·7	554	553·9	9·7
315	315·0	5·5	375	374·9	6·5	435	434·9	7·6	495	494·9	8·7	555	554·9	9·7
316	316·0	5·5	376	375·9	6·6	436	435·9	7·6	496	495·9	8·7	556	555·9	9·7
317	317·0	5·5	377	376·9	6·6	437	436·9	7·6	497	496·9	8·7	557	556·9	9·7
318	318·0	5·5	378	377·9	6·6	438	437·9	7·6	498	497·9	8·7	558	557·9	9·7
319	319·0	5·6	379	378·9	6·6	439	438·9	7·7	499	498·9	8·8	559	558·9	9·8
320	320·0	5·6	380	379·9	6·6	440	439·9	7·7	500	499·9	8·8	560	559·9	9·8
321	321·0	5·6	381	380·9	6·7	441	440·9	7·7	501	500·9	8·8	561	560·9	9·8
322	322·0	5·6	382	381·9	6·7	442	441·9	7·7	502	501·9	8·8	562	561·9	9·8
323	323·0	5·6	383	382·9	6·7	443	442·9	7·7	503	502·9	8·8	563	562·9	9·8
324	324·0	5·6	384	383·9	6·7	444	443·9	7·7	504	503·9	8·8	564	563·9	9·8
325	325·0	5·7	385	384·9	6·7	445	444·9	7·8	505	504·9	8·8	565	564·9	9·9
326	326·0	5·7	386	385·9	6·7	446	445·9	7·8	506	505·9	8·9	566	565·9	9·9
327	327·0	5·7	387	386·9	6·8	447	446·9	7·8	507	506·9	8·9	567	566·9	9·9
328	328·0	5·7	388	387·9	6·8	448	447·9	7·8	508	507·9	8·9	568	567·9	9·9
329	329·0	5·7	389	388·9	6·8	449	448·9	7·8	509	508·9	8·9	569	568·9	9·9
330	330·0	5·8	390	389·9	6·8	450	449·9	7·8	510	509·9	8·9	570	569·9	9·9
331	331·0	5·8	391	390·9	6·8	451	450·9	7·9	511	510·9	9·0	571	570·9	10·0
332	332·0	5·8	392	391·9	6·8	452	451·9	7·9	512	511·9	9·0	572	571·9	10·0
333	333·0	5·8	393	392·9	6·9	453	452·9	7·9	513	512·9	9·0	573	572·9	10·0
334	333·9	5·8	394	393·9	6·9	454	453·9	7·9	514	513·9	9·0	574	573·9	10·0
335	334·9	5·8	395	394·9	6·9	455	454·9	7·9	515	514·9	9·0	575	574·9	10·0
336	335·9	5·9	396	395·9	6·9	456	455·9	8·0	516	515·9	9·0	576	575·9	10·0
337	336·9	5·9	397	396·9	6·9	457	456·9	8·0	517	516·9	9·1	577	576·9	10·1
338	337·9	5·9	398	397·9	6·9	458	457·9	8·0	518	517·9	9·1	578	577·9	10·1
339	338·9	5·9	399	398·9	7·0	459	458·9	8·0	519	518·9	9·1	579	578·9	10·1
340	339·9	5·9	400	399·9	7·0	460	459·9	8·0	520	519·9	9·1	580	579·9	10·1
341	340·9	6·0	401	400·9	7·0	461	460·9	8·0	521	520·9	9·1	581	580·9	10·1
342	341·9	6·0	402	401·9	7·0	462	461·9	8·1	522	521·9	9·1	582	581·9	10·1
343	342·9	6·0	403	402·9	7·0	463	462·9	8·1	523	522·9	9·2	583	582·9	10·2
344	343·9	6·0	404	403·9	7·1	464	463·9	8·1	524	523·9	9·2	584	583·9	10·2
345	344·9	6·0	405	404·9	7·1	465	464·9	8·1	525	524·9	9·2	585	584·9	10·2
346	345·9	6·0	406	405·9	7·1	466	465·9	8·1	526	525·9	9·2	586	585·9	10·2
347	346·9	6·1	407	406·9	7·1	467	466·9	8·1	527	526·9	9·2	587	586·9	10·2
348	347·9	6·1	408	407·9	7·1	468	467·9	8·2	528	527·9	9·2	588	587·9	10·2
349	348·9	6·1	409	408·9	7·1	469	468·9	8·2	529	528·9	9·3	589	588·9	10·3
350	349·9	6·1	410	409·9	7·2	470	469·9	8·2	530	529·9	9·3	590	589·9	10·3
351	350·9	6·1	411	410·9	7·2	471	470·9	8·2	531	530·9	9·3	591	590·9	10·3
352	351·9	6·1	412	411·9	7·2	472	471·9	8·2	532	531·9	9·3	592	591·9	10·3
353	352·9	6·2	413	412·9	7·2	473	472·9	8·2	533	532·9	9·3	593	592·9	10·3
354	353·9	6·2	414	413·9	7·2	474	473·9	8·3	534	533·9	9·3	594	593·9	10·3
355	354·9	6·2	415	414·9	7·2	475	474·9	8·3	535	534·9	9·4	595	594·9	10·4
356	355·9	6·2	416	415·9	7·3	476	475·9	8·3	536	535·9	9·4	596	595·9	10·4
357	356·9	6·2	417	416·9	7·3	477	476·9	8·3	537	536·9	9·4	597	596·9	10·4
358	357·9	6·2	418	417·9	7·3	478	477·9	8·3	538	537·9	9·4	598	597·9	10·4
359	358·9	6·3	419	418·9	7·3	479	478·9	8·4	539	538·9	9·4	599	598·9	10·4
360	359·9	6·3	420	419·9	7·3	480	479·9	8·4	540	539·9	9·4	600	599·9	10·5
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

89° 5h 56m

TRAVERSE TABLE TO DEGREES

2° 0h 8m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	1·0	0·0	61	61·0	2·1	121	120·9	4·2	181	180·9	6·3	241	240·9	8·4
2	2·0	0·1	62	62·0	2·2	122	121·9	4·3	182	181·9	6·4	242	241·9	8·4
3	3·0	0·1	63	63·0	2·2	123	122·9	4·3	183	182·9	6·4	243	242·9	8·5
4	4·0	0·1	64	64·0	2·2	124	123·9	4·3	184	183·9	6·4	244	243·9	8·5
5	5·0	0·2	65	65·0	2·3	125	124·9	4·4	185	184·9	6·5	245	244·9	8·6
6	6·0	0·2	66	66·0	2·3	126	125·9	4·4	186	185·9	6·5	246	245·9	8·6
7	7·0	0·2	67	67·0	2·3	127	126·9	4·4	187	186·9	6·5	247	246·8	8·6
8	8·0	0·3	68	68·0	2·4	128	127·9	4·5	188	187·9	6·6	248	247·8	8·7
9	9·0	0·3	69	69·0	2·4	129	128·9	4·5	189	188·9	6·6	249	248·8	8·7
10	10·0	0·3	70	70·0	2·4	130	129·9	4·5	190	189·9	6·6	250	249·8	8·7
11	11·0	0·4	71	71·0	2·5	131	130·9	4·6	191	190·9	6·7	251	250·8	8·8
12	12·0	0·4	72	72·0	2·5	132	131·9	4·6	192	191·9	6·7	252	251·8	8·8
13	13·0	0·5	73	73·0	2·5	133	132·9	4·6	193	192·9	6·7	253	252·8	8·8
14	14·0	0·5	74	74·0	2·6	134	133·9	4·7	194	193·9	6·8	254	253·8	8·9
15	15·0	0·5	75	75·0	2·6	135	134·9	4·7	195	194·9	6·8	255	254·8	8·9
16	16·0	0·6	76	76·0	2·7	136	135·9	4·7	196	195·9	6·8	256	255·8	8·9
17	17·0	0·6	77	77·0	2·7	137	136·9	4·8	197	196·9	6·9	257	256·8	9·0
18	18·0	0·6	78	78·0	2·7	138	137·9	4·8	198	197·9	6·9	258	257·8	9·0
19	19·0	0·7	79	79·0	2·8	139	138·9	4·9	199	198·9	6·9	259	258·8	9·0
20	20·0	0·7	80	80·0	2·8	140	139·9	4·9	200	199·9	7·0	260	259·8	9·1
21	21·0	0·7	81	81·0	2·8	141	140·9	4·9	201	200·9	7·0	261	260·8	9·1
22	22·0	0·8	82	82·0	2·9	142	141·9	5·0	202	201·9	7·0	262	261·8	9·1
23	23·0	0·8	83	82·9	2·9	143	142·9	5·0	203	202·9	7·1	263	262·8	9·2
24	24·0	0·8	84	83·9	2·9	144	143·9	5·0	204	203·9	7·1	264	263·8	9·2
25	25·0	0·9	85	84·9	3·0	145	144·9	5·1	205	204·9	7·2	265	264·8	9·2
26	26·0	0·9	86	85·9	3·0	146	145·9	5·1	206	205·9	7·2	266	265·8	9·3
27	27·0	0·9	87	86·9	3·0	147	146·9	5·1	207	206·9	7·2	267	266·8	9·3
28	28·0	1·0	88	87·9	3·1	148	147·9	5·2	208	207·9	7·3	268	267·8	9·4
29	29·0	1·0	89	88·9	3·1	149	148·9	5·2	209	208·9	7·3	269	268·8	9·4
30	30·0	1·0	90	89·9	3·1	150	149·9	5·2	210	209·9	7·3	270	269·8	9·4
31	31·0	1·1	91	90·9	3·2	151	150·9	5·3	211	210·9	7·4	271	270·8	9·5
32	32·0	1·1	92	91·9	3·2	152	151·9	5·3	212	211·9	7·4	272	271·8	9·5
33	33·0	1·2	93	92·9	3·2	153	152·9	5·3	213	212·9	7·4	273	272·8	9·5
34	34·0	1·2	94	93·9	3·3	154	153·9	5·4	214	213·9	7·5	274	273·8	9·6
35	35·0	1·2	95	94·9	3·3	155	154·9	5·4	215	214·9	7·5	275	274·8	9·6
36	36·0	1·3	96	95·9	3·4	156	155·9	5·4	216	215·9	7·5	276	275·8	9·6
37	37·0	1·3	97	96·9	3·4	157	156·9	5·5	217	216·9	7·6	277	276·8	9·7
38	38·0	1·3	98	97·9	3·4	158	157·9	5·5	218	217·9	7·6	278	277·8	9·7
39	39·0	1·4	99	98·9	3·5	159	158·9	5·5	219	218·9	7·6	279	278·8	9·7
40	40·0	1·4	100	99·9	3·5	160	159·9	5·6	220	219·9	7·7	280	279·8	9·8
41	41·0	1·4	101	100·9	3·5	161	160·9	5·6	221	220·9	7·7	281	280·8	9·8
42	42·0	1·5	102	101·9	3·6	162	161·9	5·7	222	221·9	7·7	282	281·8	9·8
43	43·0	1·5	103	102·9	3·6	163	162·9	5·7	223	222·9	7·8	283	282·8	9·9
44	44·0	1·5	104	103·9	3·6	164	163·9	5·7	224	223·9	7·8	284	283·8	9·9
45	45·0	1·6	105	104·9	3·7	165	164·9	5·8	225	224·9	7·9	285	284·8	9·9
46	46·0	1·6	106	105·9	3·7	166	165·9	5·8	226	225·9	7·9	286	285·8	10·0
47	47·0	1·6	107	106·9	3·7	167	166·9	5·8	227	226·9	7·9	287	286·8	10·0
48	48·0	1·7	108	107·9	3·8	168	167·9	5·9	228	227·9	8·0	288	287·8	10·1
49	49·0	1·7	109	108·9	3·8	169	168·9	5·9	229	228·9	8·0	289	288·8	10·1
50	50·0	1·7	110	109·9	3·8	170	169·9	5·9	230	229·9	8·0	290	289·8	10·1
51	51·0	1·8	111	110·9	3·9	171	170·9	6·0	231	230·9	8·1	291	290·8	10·2
52	52·0	1·8	112	111·9	3·9	172	171·9	6·0	232	231·9	8·1	292	291·8	10·2
53	53·0	1·8	113	112·9	3·9	173	172·9	6·0	233	232·9	8·1	293	292·8	10·2
54	54·0	1·9	114	113·9	4·0	174	173·9	6·1	234	233·9	8·2	294	293·8	10·3
55	55·0	1·9	115	114·9	4·0	175	174·9	6·1	235	234·9	8·2	295	294·8	10·3
56	56·0	2·0	116	115·9	4·0	176	175·9	6·1	236	235·9	8·2	296	295·8	10·3
57	57·0	2·0	117	116·9	4·1	177	176·9	6·2	237	236·9	8·3	297	296·8	10·4
58	58·0	2·0	118	117·9	4·1	178	177·9	6·2	238	237·9	8·3	298	297·8	10·4
59	59·0	2·1	119	118·9	4·2	179	178·9	6·2	239	238·9	8·3	299	298·8	10·4
60	60·0	2·1	120	119·9	4·2	180	179·9	6·3	240	239·9	8·4	300	299·8	10·5
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

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TRAVERSE TABLE TO DEGREES

2° 0h 8m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	300·8	10·5	361	360·8	12·6	421	420·8	14·7	481	480·7	16·8	541	540·7	18·9
302	301·8	10·5	362	361·8	12·6	422	421·8	14·7	482	481·7	16·8	542	541·7	18·9
303	302·8	10·6	363	362·8	12·7	423	422·8	14·7	483	482·7	16·8	543	542·7	18·9
304	303·8	10·6	364	363·8	12·7	424	423·8	14·8	484	483·7	16·9	544	543·7	19·0
305	304·8	10·6	365	364·8	12·7	425	424·8	14·8	485	484·7	16·9	545	544·7	19·0
306	305·8	10·7	366	365·8	12·8	426	425·7	14·9	486	485·7	16·9	546	545·7	19·0
307	306·8	10·7	367	366·8	12·8	427	426·7	14·9	487	486·7	17·0	547	546·7	19·1
308	307·8	10·7	368	367·8	12·8	428	427·7	14·9	488	487·7	17·0	548	547·7	19·1
309	308·8	10·8	369	368·8	12·9	429	428·7	15·0	489	488·7	17·0	549	548·7	19·1
310	309·8	10·8	370	369·8	12·9	430	429·7	15·0	490	489·7	17·1	550	549·7	19·2
311	310·8	10·8	371	370·8	12·9	431	430·7	15·0	491	490·7	17·1	551	550·7	19·2
312	311·8	10·9	372	371·8	13·0	432	431·7	15·1	492	491·7	17·1	552	551·7	19·2
313	312·8	10·9	373	372·8	13·0	433	432·7	15·1	493	492·7	17·2	553	552·7	19·3
314	313·8	10·9	374	373·8	13·0	434	433·7	15·1	494	493·7	17·2	554	553·7	19·3
315	314·8	11·0	375	374·8	13·1	435	434·7	15·2	495	494·7	17·2	555	554·7	19·3
316	315·8	11·0	376	375·8	13·1	436	435·7	15·2	496	495·7	17·3	556	555·7	19·4
317	316·8	11·0	377	376·8	13·1	437	436·7	15·2	497	496·7	17·3	557	556·7	19·4
318	317·8	11·1	378	377·8	13·2	438	437·7	15·3	498	497·7	17·3	558	557·7	19·4
319	318·8	11·1	379	378·8	13·2	439	438·7	15·3	499	498·7	17·4	559	558·7	19·5
320	319·8	11·2	380	379·8	13·2	440	439·7	15·3	500	499·7	17·4	560	559·7	19·5
321	320·8	11·2	381	380·8	13·3	441	440·7	15·4	501	500·7	17·5	561	560·7	19·5
322	321·8	11·2	382	381·8	13·3	442	441·7	15·4	502	501·7	17·5	562	561·7	19·6
323	322·8	11·3	383	382·8	13·3	443	442·7	15·4	503	502·7	17·5	563	562·7	19·6
324	323·8	11·3	384	383·8	13·4	444	443·7	15·5	504	503·7	17·6	564	563·7	19·6
325	324·8	11·3	385	384·8	13·4	445	444·7	15·5	505	504·7	17·6	565	564·7	19·7
326	325·8	11·4	386	385·8	13·5	446	445·7	15·6	506	505·7	17·6	566	565·7	19·7
327	326·8	11·4	387	386·8	13·5	447	446·7	15·6	507	506·7	17·7	567	566·7	19·7
328	327·8	11·4	388	387·8	13·5	448	447·7	15·6	508	507·7	17·7	568	567·7	19·8
329	328·8	11·5	389	388·8	13·6	449	448·7	15·7	509	508·7	17·7	569	568·7	19·8
330	329·8	11·5	390	389·8	13·6	450	449·7	15·7	510	509·7	17·8	570	569·7	19·9
331	330·8	11·5	391	390·8	13·6	451	450·7	15·7	511	510·7	17·8	571	570·7	19·9
332	331·8	11·6	392	391·8	13·7	452	451·7	15·8	512	511·7	17·8	572	571·7	19·9
333	332·8	11·6	393	392·8	13·7	453	452·7	15·8	513	512·7	17·9	573	572·7	20·0
334	333·8	11·6	394	393·8	13·7	454	453·7	15·8	514	513·7	17·9	574	573·6	20·0
335	334·8	11·7	395	394·8	13·8	455	454·7	15·9	515	514·7	17·9	575	574·6	20·0
336	335·8	11·7	396	395·8	13·8	456	455·7	15·9	516	515·7	18·0	576	575·6	20·1
337	336·8	11·7	397	396·8	13·8	457	456·7	15·9	517	516·7	18·0	577	576·6	20·1
338	337·8	11·8	398	397·8	13·9	458	457·7	16·0	518	517·7	18·1	578	577·6	20·1
339	338·8	11·8	399	398·8	13·9	459	458·7	16·0	519	518·7	18·1	579	578·6	20·2
340	339·8	11·9	400	399·8	13·9	460	459·7	16·0	520	519·7	18·1	580	579·6	20·2
341	340·8	11·9	401	400·8	14·0	461	460·7	16·1	521	520·7	18·2	581	580·6	20·2
342	341·8	11·9	402	401·8	14·0	462	461·7	16·1	522	521·7	18·2	582	581·6	20·3
343	342·8	12·0	403	402·8	14·0	463	462·7	16·1	523	522·7	18·2	583	582·6	20·3
344	343·8	12·0	404	403·8	14·1	464	463·7	16·2	524	523·7	18·3	584	583·6	20·3
345	344·8	12·0	405	404·8	14·1	465	464·7	16·2	525	524·7	18·3	585	584·6	20·4
346	345·8	12·1	406	405·8	14·2	466	465·7	16·2	526	525·7	18·4	586	585·6	20·4
347	346·8	12·1	407	406·8	14·2	467	466·7	16·3	527	526·7	18·4	587	586·6	20·4
348	347·8	12·1	408	407·8	14·2	468	467·7	16·3	528	527·7	18·4	588	587·6	20·5
349	348·8	12·2	409	408·8	14·3	469	468·7	16·4	529	528·7	18·5	589	588·6	20·5
350	349·8	12·2	410	409·8	14·3	470	469·7	16·4	530	529·7	18·5	590	589·6	20·5
351	350·8	12·2	411	410·8	14·3	471	470·7	16·4	531	530·7	18·5	591	590·6	20·6
352	351·8	12·3	412	411·8	14·4	472	471·7	16·5	532	531·7	18·6	592	591·6	20·6
353	352·8	12·3	413	412·8	14·4	473	472·7	16·5	533	532·7	18·6	593	592·6	20·6
354	353·8	12·3	414	413·8	14·4	474	473·7	16·5	534	533·7	18·6	594	593·6	20·7
355	354·8	12·4	415	414·8	14·5	475	474·7	16·6	535	534·7	18·7	595	594·6	20·7
356	355·8	12·4	416	415·8	14·5	476	475·7	16·6	536	535·7	18·7	596	595·6	20·7
357	356·8	12·4	417	416·8	14·5	477	476·7	16·6	537	536·7	18·7	597	596·6	20·8
358	357·8	12·5	418	417·8	14·6	478	477·7	16·7	538	537·7	18·8	598	597·6	20·8
359	358·8	12·5	419	418·8	14·6	479	478·7	16·7	539	538·7	18·8	599	598·6	20·8
360	359·8	12·5	420	419·8	14·6	480	479·7	16·7	540	539·7	18·8	600	599·6	20·9
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

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TRAVERSE TABLE TO DEGREES

3° 0h 12m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	1·0	0·1	61	60·9	3·2	121	120·8	6·3	181	180·8	9·5	241	240·7	12·6
2	2·0	0·1	62	61·9	3·2	122	121·8	6·4	182	181·8	9·5	242	241·7	12·7
3	3·0	0·2	63	62·9	3·3	123	122·8	6·4	183	182·7	9·6	243	242·7	12·7
4	4·0	0·2	64	63·9	3·3	124	123·8	6·5	184	183·7	9·6	244	243·7	12·8
5	5·0	0·3	65	64·9	3·4	125	124·8	6·5	185	184·7	9·7	245	244·7	12·8
6	6·0	0·3	66	65·9	3·5	126	125·8	6·6	186	185·7	9·7	246	245·7	12·9
7	7·0	0·4	67	66·9	3·5	127	126·8	6·6	187	186·7	9·8	247	246·7	12·9
8	8·0	0·4	68	67·9	3·6	128	127·8	6·7	188	187·7	9·8	248	247·7	13·0
9	9·0	0·5	69	68·9	3·6	129	128·8	6·8	189	188·7	9·9	249	248·7	13·0
10	10·0	0·5	70	69·9	3·7	130	129·8	6·8	190	189·7	9·9	250	249·7	13·1
11	11·0	0·6	71	70·9	3·7	131	130·8	6·9	191	190·7	10·0	251	250·7	13·1
12	12·0	0·6	72	71·9	3·8	132	131·8	6·9	192	191·7	10·0	252	251·7	13·2
13	13·0	0·7	73	72·9	3·8	133	132·8	7·0	193	192·7	10·1	253	252·7	13·2
14	14·0	0·7	74	73·9	3·9	134	133·8	7·0	194	193·7	10·2	254	253·7	13·3
15	15·0	0·8	75	74·9	3·9	135	134·8	7·1	195	194·7	10·2	255	254·7	13·3
16	16·0	0·8	76	75·9	4·0	136	135·8	7·1	196	195·7	10·3	256	255·6	13·4
17	17·0	0·9	77	76·9	4·0	137	136·8	7·2	197	196·7	10·3	257	256·6	13·5
18	18·0	0·9	78	77·9	4·1	138	137·8	7·2	198	197·7	10·4	258	257·6	13·5
19	19·0	1·0	79	78·9	4·1	139	138·8	7·3	199	198·7	10·4	259	258·6	13·6
20	20·0	1·0	80	79·9	4·2	140	139·8	7·3	200	199·7	10·5	260	259·6	13·6
21	21·0	1·1	81	80·9	4·2	141	140·8	7·4	201	200·7	10·5	261	260·6	13·7
22	22·0	1·1	82	81·9	4·3	142	141·8	7·4	202	201·7	10·6	262	261·6	13·7
23	23·0	1·2	83	82·9	4·3	143	142·8	7·5	203	202·7	10·6	263	262·6	13·8
24	24·0	1·2	84	83·9	4·4	144	143·8	7·5	204	203·7	10·7	264	263·6	13·8
25	25·0	1·3	85	84·9	4·4	145	144·8	7·6	205	204·7	10·7	265	264·6	13·9
26	26·0	1·4	86	85·9	4·5	146	145·8	7·6	206	205·7	10·8	266	265·6	13·9
27	27·0	1·4	87	86·9	4·6	147	146·8	7·7	207	206·7	10·8	267	266·6	14·0
28	28·0	1·5	88	87·9	4·6	148	147·8	7·7	208	207·7	10·9	268	267·6	14·0
29	29·0	1·5	89	88·9	4·7	149	148·8	7·8	209	208·7	10·9	269	268·6	14·1
30	30·0	1·6	90	89·9	4·7	150	149·8	7·9	210	209·7	11·0	270	269·6	14·1
31	31·0	1·6	91	90·9	4·8	151	150·8	7·9	211	210·7	11·0	271	270·6	14·2
32	32·0	1·7	92	91·9	4·8	152	151·8	8·0	212	211·7	11·1	272	271·6	14·2
33	33·0	1·7	93	92·9	4·9	153	152·8	8·0	213	212·7	11·1	273	272·6	14·3
34	34·0	1·8	94	93·9	4·9	154	153·8	8·1	214	213·7	11·2	274	273·6	14·3
35	35·0	1·8	95	94·9	5·0	155	154·8	8·1	215	214·7	11·3	275	274·6	14·4
36	36·0	1·9	96	95·9	5·0	156	155·8	8·2	216	215·7	11.3	276	275·6	14·4
37	36·9	1·9	97	96·9	5·1	157	156·8	8·2	217	216·7	11·4	277	276·6	14·5
38	37·9	2·0	98	97·9	5·1	158	157·8	8·3	218	217·7	11·4	278	277·6	14·5
39	38·9	2·0	99	98·9	5·2	159	158·8	8·3	219	218·7	11·5	279	278·6	14·6
40	39·9	2·1	100	99·9	5·2	160	159·8	8·4	220	219·7	11·5	280	279·6	14·7
41	40·9	2·1	101	100·9	5·3	161	160·8	8·4	221	220·7	11·6	281	280·6	14·7
42	41·9	2·2	102	101·9	5·3	162	161·8	8·5	222	221·7	11·6	282	281·6	14·8
43	42·9	2·3	103	102·9	5·4	163	162·8	8·5	223	222·7	11·7	283	282·6	14·8
44	43·9	2·3	104	103·9	5·4	164	163·8	8·6	224	223·7	11·7	284	283·6	14·9
45	44·9	2·4	105	104·9	5·5	165	164·8	8·6	225	224·7	11·8	285	284·6	14·9
46	45·9	2·4	106	105·9	5·5	166	165·8	8·7	226	225·7	11·8	286	285·6	15·0
47	46·9	2·5	107	106·9	5·6	167	166·8	8·7	227	226·7	11·9	287	286·6	15·0
48	47·9	2·5	108	107·9	5·7	168	167·8	8·8	228	227·7	11·9	288	287·6	15·1
49	48·9	2·6	109	108·9	5·7	169	168·8	8·8	229	228·7	12·0	289	288·6	15·1
50	49·9	2.6	110	109·9	5·8	170	169·8	8·9	230	229·7	12·0	290	289·6	15·2
51	50·9	2·7	111	110·8	5·8	171	170·8	8·9	231	230·7	12·1	291	290·6	15·2
52	51·9	2·7	112	111·8	5·9	172	171·8	9·0	232	231·7	12·1	292	291·6	15·3
53	52·9	2·8	113	112·8	5·9	173	172·8	9·1	233	232·7	12·2	293	292·6	15·3
54	53·9	2·8	114	113·8	6·0	174	173·8	9·1	234	233·7	12·2	294	293·6	15·4
55	54·9	2·9	115	114·8	6·0	175	174·8	9·2	235	234·7	12·3	295	294·6	15·4
56	55·9	2·9	116	115·8	6·1	176	175·8	9·2	236	235·7	12·4	296	295·6	15·5
57	56·9	3·0	117	116·8	6·1	177	176·8	9·3	237	236·7	12·4	297	296·6	15·5
58	57·9	3·0	118	117·8	6·2	178	177·8	9·3	238	237·7	12·5	298	297·6	15·6
59	58·9	3·1	119	118·8	6·2	179	178·8	9·4	239	238·7	12·5	299	298·6	15·6
60	59·9	3·1	120	119·8	6·3	180	179·8	9·4	240	239·7	12·6	300	299·6	15·7
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

87° 5h 48m

TRAVERSE TABLE TO DEGREES

3° 0h 12m

Dist.	D. Lat	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	300·6	15·7	361	360·5	18·9	421	420·4	22·0	481	480·3	25·2	541	540·2	28·3
302	301·6	15·8	362	361·5	19·0	422	421·4	22·1	482	481·3	25·2	542	541·2	28·4
303	302·6	15·9	363	362·5	19·0	423	422·4	22·2	483	482·3	25·3	543	542·2	28·4
304	303·5	15·9	364	363·5	19·1	424	423·4	22·2	484	483·3	25·3	544	543·2	28·5
305	304·5	16·0	365	364·5	19·1	425	424·4	22·3	485	484·3	25·4	545	544·2	28·5
306	305·5	16·0	366	365·5	19·2	426	425·4	22·3	486	485·3	25·4	546	545·2	28·6
307	306·5	16·1	367	366·5	19·2	427	426·4	22·4	487	486·3	25·5	547	546·2	28·6
308	307·5	16·1	368	367·5	19·3	428	427·4	22·4	488	487·3	25·5	548	547·2	28·7
309	308·5	16·2	369	368·5	19·3	429	428·4	22·5	489	488·3	25·6	549	548·2	28·7
310	309·5	16·2	370	369·5	19·4	430	429·4	22·5	490	489·3	25·6	550	549·2	28·8
311	310·5	16·3	371	370·5	19·4	431	430·4	22·6	491	490·3	25·7	551	550·2	28·8
312	311·5	16·3	372	371·5	19·5	432	431·4	22·6	492	491·3	25·7	552	551·2	28·9
313	312·5	16·4	373	372·5	19·5	433	432·4	22·7	493	492·3	25·8	553	552·2	28·9
314	313·5	16·4	374	373·5	19·6	434	433·4	22·7	494	493·3	25·9	554	553·2	29·0
315	314·5	16·5	375	374·5	19·6	435	434·4	22·8	495	494·3	25·9	555	554·2	29·1
316	315·5	16·6	376	375·5	19·7	436	435·4	22·8	496	495·3	26·0	556	555·2	29·1
317	316·5	16·6	377	376·5	19·8	437	436·4	22·9	497	496·3	26·0	557	556·2	29·2
318	317·5	16·7	378	377·4	19·8	438	437·4	22·9	498	497·3	26·1	558	557·2	29·2
319	318·5	16·7	379	378·4	19·9	439	438·4	23·0	499	498·3	26·1	559	558·2	29·3
320	319·5	16·8	380	379·4	19·9	440	439·4	23·0	500	499·3	26·2	560	559·2	29·3
321	320·5	16·8	381	380·4	20·0	441	440·4	23·1	501	500·3	26·2	561	560·2	29·4
322	321·5	16·9	382	381·4	20·0	442	441·4	23·1	502	501·3	26·3	562	561·2	29·4
323	322·5	16·9	383	382·4	20·1	443	442·4	23·2	503	502·3	26·3	563	562·2	29·5
324	323·5	17·0	384	383·4	20·1	444	443·4	23·3	504	503·3	26·4	564	563·2	29·5
325	324·5	17·0	385	384·4	20·2	445	444·4	23·3	505	504·3	26·4	565	564·2	29·6
326	325·5	17·1	386	385·4	20·2	446	445·4	23·4	506	505·3	26·5	566	565·2	29·6
327	326·5	17·1	387	386·4	20·3	447	446·4	23·4	507	506·3	26·5	567	566·2	29·7
328	327·5	17·2	388	387·4	20·3	448	447·4	23·5	508	507·3	26·6	568	567·2	29·7
329	328·5	17·2	389	388·4	20·4	449	448·4	23·5	509	508·3	26·6	569	568·2	29·8
330	329·5	17·3	390	389·4	20·4	450	449·3	23·6	510	509·3	26·7	570	569·2	29·8
331	330·5	17·3	391	390·4	20·5	451	450·3	23·6	511	510·3	26·7	571	570·2	29·9
332	331·5	17·4	392	391·4	20·5	452	451·3	23·7	512	511·3	26·8	572	571·2	29·9
333	332·5	17·5	393	392·4	20·6	453	452·3	23·7	513	512·3	26·8	573	572·2	30·0
334	333·5	17·5	394	393·4	20·6	454	453·3	23·8	514	513·3	26·9	574	573·2	30·0
335	334·5	17·6	395	394·4	20·7	455	454·3	23·8	515	514·3	27·0	575	574·2	30·1
336	335·5	17·6	396	395·4	20·7	456	455·3	23·9	516	515·3	27·0	576	575·2	30·1
337	336·5	17·7	397	396·4	20·8	457	456·3	23·9	517	516·3	27·1	577	576·2	30·2
338	337·5	17·7	398	397·4	20·8	458	457·3	24·0	518	517·3	27·1	578	577·2	30·2
339	338·5	17·8	399	398·4	20·9	459	458·3	24·0	519	518·3	27·2	579	578·2	30·3
340	339·5	17·8	400	399·4	20·9	460	459·3	24·1	520	519·3	27·2	580	579·2	30·3
341	340·5	17·9	401	400·4	21·0	461	460·3	24·1	521	520·3	27·3	581	580·2	30·4
342	341·5	17·9	402	401·4	21·1	462	461·3	24·2	522	521·3	27·3	582	581·2	30·4
343	342·5	18·0	403	402·4	21·1	463	462·3	24·2	523	522·3	27·4	583	582·2	30·5
344	343·5	18·0	404	403·4	21·2	464	463·3	24·3	524	523·3	27·4	584	583·2	30·5
345	344·5	18·1	405	404·4	21·2	465	464·3	24·4	525	524·3	27·5	585	584·2	30·6
346	345·5	18·1	406	405·4	21·3	466	465·3	24·4	526	525·3	27·5	586	585·2	30·6
347	346·5	18·2	407	406·4	21·3	467	466·3	24·5	527	526·3	27·6	587	586·2	30·7
348	347·5	18·2	408	407·4	21·4	468	467·3	24·5	528	527·3	27·6	588	587·2	30·7
349	348·5	18·3	409	408·4	21·4	469	468·3	24·6	529	528·3	27·7	589	588·2	30·8
350	349·5	18·3	410	409·4	21·5	470	469·3	24·6	530	529·3	27·7	590	589·2	30·9
351	350·5	18·4	411	410·4	21·5	471	470·3	24·7	531	530·3	27·8	591	590·2	30·9
352	351·5	18·4	412	411·4	21·6	472	471·3	24·7	532	531·3	27·8	592	591·2	31·0
353	352·5	18·5	413	412·4	21·6	473	472·3	24·8	533	532·3	27·9	593	592·2	31·0
354	353·5	18·5	414	413·4	21·7	474	473·3	24·8	534	533·3	27·9	594	593·2	31·1
355	354·5	18·6	415	414·4	21·7	475	474·3	24·9	535	534·3	28·0	595	594·2	31·1
356	355·5	18·6	416	415·4	21·8	476	475·3	24·9	536	535·3	28·1	596	595·2	31·2
357	356·5	18·7	417	416·4	21·8	477	476·3	25·0	537	536·3	28·1	597	596·2	31·2
358	357·5	18·8	418	417·4	21·9	478	477·3	25·0	538	537·3	28·2	598	597·2	31·3
359	358·5	18·8	419	418·4	21·9	479	478·3	25·1	539	538·3	28·2	599	598·2	31·3
360	359·5	18·9	420	419·4	22·0	480	479·3	25·1	540	539·3	28·3	600	599·2	31·4
Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat.

87° 5h 48m

TRAVERSE TABLE TO DEGREES

4° $0^h\ 16^m$

Dist.	D.Lat	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	1·0	0·1	61	60·9	4·3	121	120·7	8·4	181	180·6	12·6	241	240·4	16·8
2	2·0	0·1	62	61·8	4·3	122	121·7	8·5	182	181·6	12·7	242	241·4	16·9
3	3·0	0·2	63	62·8	4·4	123	122·7	8·6	183	182·6	12·8	243	242·4	17·0
4	4·0	0·3	64	63·8	4·5	124	123·7	8·6	184	183·6	12·8	244	243·4	17·0
5	5·0	0·3	65	64·8	4·5	125	124·7	8·7	185	184·5	12·9	245	244·4	17·1
6	6·0	0·4	66	65·8	4·6	126	125·7	8·8	186	185·5	13·0	246	245·4	17·2
7	7·0	0·5	67	66·8	4·7	127	126·7	8·9	187	186·5	13·0	247	246·4	17·2
8	8·0	0·6	68	67·8	4·7	128	127·7	8·9	188	187·5	13·1	248	247·4	17·3
9	9·0	0·6	69	68·8	4·8	129	128·7	9·0	189	188·5	13·2	249	248·4	17·4
10	10·0	0·7	70	69·8	4·9	130	129·7	9·1	190	189·5	13·3	250	249·4	17·4
11	11·0	0·8	71	70·8	5·0	131	130·7	9·1	191	190·5	13·3	251	250·4	17·5
12	12·0	0·8	72	71·8	5·0	132	131·7	9·2	192	191·5	13·4	252	251·4	17·6
13	13·0	0·9	73	72·8	5·1	133	132·7	9·3	193	192·5	13·5	253	252·4	17·6
14	14·0	1·0	74	73·8	5·2	134	133·7	9·3	194	193·5	13·5	254	253·4	17·7
15	15·0	1·0	75	74·8	5·2	135	134·7	9·4	195	194·5	13·6	255	254·4	17·8
16	16·0	1·1	76	75·8	5·3	136	135·7	9·5	196	195·5	13·7	256	255·4	17·9
17	17·0	1·2	77	76·8	5·4	137	136·7	9·6	197	196·5	13·7	257	256·4	17·9
18	18·0	1·3	78	77·8	5·4	138	137·7	9·6	198	197·5	13·8	258	257·4	18·0
19	19·0	1·3	79	78·8	5·5	139	138·7	9·7	199	198·5	13·9	259	258·4	18·1
20	20·0	1·4	80	79·8	5·6	140	139·7	9·8	200	199·5	14·0	260	259·4	18·1
21	20·9	1·5	81	80·8	5·7	141	140·7	9·8	201	200·5	14·0	261	260·4	18·2
22	21·9	1·5	82	81·8	5·7	142	141·7	9·9	202	201·5	14·1	262	261·4	18·3
23	22·9	1·6	83	82·8	5·8	143	142·7	10·0	203	202·5	14·2	263	262·4	18·3
24	23·9	1·7	84	83·8	5·9	144	143·6	10·0	204	203·5	14·2	264	263·4	18·4
25	24·9	1·7	85	84·8	5·9	145	144·6	10·1	205	204·5	14·3	265	264·4	18·5
26	25·9	1·8	86	85·8	6·0	146	145·6	10·2	206	205·5	14·4	266	265·4	18·6
27	26·9	1·9	87	86·8	6·1	147	146·6	10·3	207	206·5	14·4	267	266·3	18·6
28	27·9	2·0	88	87·8	6·1	148	147·6	10·3	208	207·5	14·5	268	267·3	18·7
29	28·9	2·0	89	88·8	6·2	149	148·6	10·4	209	208·5	14·6	269	268·3	18·8
30	29·9	2·1	90	89·8	6·3	150	149·6	10·5	210	209·5	14·6	270	269·3	18·8
31	30·9	2·2	91	90·8	6·3	151	150·6	10·5	211	210·5	14·7	271	270·3	18·9
32	31·9	2·2	92	91·8	6·4	152	151·6	10·6	212	211·5	14·8	272	271·3	19·0
33	32·9	2·3	93	92·8	6·5	153	152·6	10·7	213	212·5	14·9	273	272·3	19·0
34	33·9	2·4	94	93·8	6·6	154	153·6	10·7	214	213·5	14·9	274	273·3	19·1
35	34·9	2·4	95	94·8	6·6	155	154·6	10·8	215	214·5	15·0	275	274·3	19·2
36	35·9	2·5	96	95·8	6·7	156	155·6	10·9	216	215·5	15·1	276	275·3	19·3
37	36·9	2·6	97	96·8	6·8	157	156·6	11·0	217	216·5	15·1	277	276·3	19·3
38	37·9	2·7	98	97·8	6·8	158	157·6	11·0	218	217·5	15·2	278	277·3	19·4
39	38·9	2·7	99	98·8	6·9	159	158·6	11·1	219	218·5	15·3	279	278·3	19·5
40	39·9	2·8	100	99·8	7·0	160	159·6	11·2	220	219·5	15·3	280	279·3	19·5
41	40·9	2·9	101	100·8	7·0	161	160·6	11·2	221	220·5	15·4	281	280·3	19·6
42	41·9	2·9	102	101·8	7·1	162	161·6	11·3	222	221·5	15·5	282	281·3	19·7
43	42·9	3·0	103	102·7	7·2	163	162·6	11·4	223	222·5	15·6	283	282·3	19·7
44	43·9	3·1	104	103·7	7·3	164	163·6	11·4	224	223·5	15·6	284	283·3	19·8
45	44·9	3·1	105	104·7	7·3	165	164·6	11·5	225	224·5	15·7	285	284·3	19·9
46	45·9	3·2	106	105·7	7·4	166	165·6	11·6	226	225·4	15·8	286	285·3	20·0
47	46·9	3·3	107	106·7	7·5	167	166·6	11·6	227	226·4	15·8	287	286·3	20·0
48	47·9	3·3	108	107·7	7·5	168	167·6	11·7	228	227·4	15·9	288	287·3	20·1
49	48·9	3·4	109	108·7	7·6	169	168·6	11·8	229	228·4	16·0	289	288·3	20·2
50	49·9	3·5	110	109·7	7·7	170	169·6	11·9	230	229·4	16·0	290	289·3	20·2
51	50·9	3·6	111	110·7	7·7	171	170·6	11·9	231	230·4	16·1	291	290·3	20·3
52	51·9	3·6	112	111·7	7·8	172	171·6	12·0	232	231·4	16·2	292	291·3	20·4
53	52·9	3·7	113	112·7	7·9	173	172·6	12·1	233	232·4	16·3	293	292·3	20·4
54	53·9	3·8	114	113·7	8·0	174	173·6	12·1	234	233·4	16·3	294	293·3	20·5
55	54·9	3·8	115	114·7	8·0	175	174·6	12·2	235	234·4	16·4	295	294·3	20·6
56	55·9	3·9	116	115·7	8·1	176	175·6	12·3	236	235·4	16·5	296	295·3	20·6
57	56·9	4·0	117	116·7	8·2	177	176·6	12·3	237	236·4	16·5	297	296·3	20·7
58	57·9	4·0	118	117·7	8·2	178	177·6	12·4	238	237·4	16·6	298	297·3	20·8
59	58·9	4·1	119	118·7	8·3	179	178·6	12·5	239	238·4	16·7	299	298·3	20·9
60	59·9	4·2	120	119·7	8·4	180	179·6	12·6	240	239·4	16·7	300	299·3	20·9
Dist.	Dep.	D.Lat	Dist.	Dep.	D.Lat	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat.

86° $5^h\ 44^m$

TRAVERSE TABLE TO DEGREES

4° 0h 16m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	300·3	21·0	361	360·1	25·2	421	420·0	29·4	481	479·8	33·5	541	539·7	37·7
302	301·3	21·1	362	361·1	25·2	422	421·0	29·4	482	480·8	33·6	542	540·7	37·8
303	302·2	21·1	363	362·1	25·3	423	422·0	29·5	483	481·8	33·7	543	541·7	37·9
304	303·2	21·2	364	363·1	25·4	424	423·0	29·6	484	482·8	33·7	544	542·7	37·9
305	304·2	21·3	365	364·1	25·5	425	424·0	29·6	485	483·8	33·8	545	543·7	38·0
306	305·2	21·3	366	365·1	25·5	426	424·9	29·7	486	484·8	33·9	546	544·7	38·1
307	306·2	21·4	367	366·1	25·6	427	425·9	29·8	487	485·8	33·9	547	545·7	38·1
308	307·2	21·5	368	367·1	25·7	428	426·9	29·9	488	486·8	34·0	548	546·7	38·2
309	308·2	21·6	369	368·1	25·7	429	427·9	29·9	489	487·8	34·1	549	547·7	38·3
310	309·2	21·6	370	369·1	25·8	430	428·9	30·0	490	488·8	34·2	550	548·7	38·3
311	310·2	21·7	371	370·1	25·9	431	429·9	30·1	491	489·8	34·2	551	549·7	38·4
312	311·2	21·8	372	371·1	25·9	432	430·9	30·1	492	490·8	34·3	552	550·7	38·5
313	312·2	21·8	373	372·1	26·0	433	431·9	30·2	493	491·8	34·4	553	551·7	38·5
314	313·2	21·9	374	373·1	26·1	434	432·9	30·3	494	492·8	34·4	554	552·7	38·6
315	314·2	22·0	375	374·1	26·2	435	433·9	30·3	495	493·8	34·5	555	553·6	38·7
316	315·2	22·1	376	375·1	26·2	436	434·9	30·4	496	494·8	34·6	556	554·6	38·7
317	316·2	22·1	377	376·1	26·3	437	435·9	30·5	497	495·8	34·6	557	555·6	38·8
318	317·2	22·2	378	377·1	26·4	438	436·9	30·6	498	496·8	34·7	558	556·6	38·9
319	318·2	22·3	379	378·1	26·4	439	437·9	30·6	499	497·8	34·8	559	557·6	38·9
320	319·2	22·3	380	379·1	26·5	440	438·9	30·7	500	498·8	34·8	560	558·6	39·0
321	320·2	22·4	381	380·1	26·6	441	439·9	30·8	501	499·8	34·9	561	559·6	39·1
322	321·2	22·5	382	381·1	26·6	442	440·9	30·8	502	500·8	35·0	562	560·6	39·2
323	322·2	22·5	383	382·1	26·7	443	441·9	30·9	503	501·8	35·0	563	561·6	39·2
324	323·2	22·6	384	383·1	26·8	444	442·9	31·0	504	502·8	35·1	564	562·6	39·3
325	324·2	22·7	385	384·0	26·9	445	443·9	31·0	505	503·8	35·2	565	563·6	39·4
326	325·2	22·7	386	385·0	26·9	446	444·9	31·1	506	504·8	35·2	566	564·6	39·4
327	326·2	22·8	387	386·0	27·0	447	445·9	31·2	507	505·8	35·3	567	565·6	39·5
328	327·2	22·9	388	387·0	27·1	448	446·9	31·2	508	506·8	35·4	568	566·6	39·6
329	328·2	23·0	389	388·0	27·1	449	447·9	31·3	509	507·8	35·5	569	567·6	39·7
330	329·2	23·0	390	389·0	27·2	450	448·9	31·4	510	508·8	35·6	570	568·6	39·8
331	330·2	23·1	391	390·0	27·3	451	449·9	31·5	511	509·8	35·6	571	569·6	39·8
332	331·2	23·2	392	391·0	27·3	452	450·9	31·5	512	510·8	35·7	572	570·6	39·9
333	332·2	23·2	393	392·0	27·4	453	451·9	31·6	513	511·8	35·8	573	571·6	40·0
334	333·2	23·3	394	393·0	27·5	454	452·9	31·7	514	512·7	35·8	574	572·6	40·0
335	334·2	23·4	395	394·0	27·6	455	453·9	31·7	515	513·7	35·9	575	573·6	40·1
336	335·2	23·4	396	395·0	27·6	456	454·9	31·8	516	514·7	36·0	576	574·6	40·2
337	336·2	23·5	397	396·0	27·7	457	455·9	31·9	517	515·7	36·0	577	575·6	40·2
338	337·2	23·6	398	397·0	27·8	458	456·9	31·9	518	516·7	36·1	578	576·6	40·3
339	338·2	23·6	399	398·0	27·8	459	457·9	32·0	519	517·7	36·2	579	577·6	40·4
340	339·2	23·7	400	399·0	27·9	460	458·9	32·1	520	518·7	36·2	580	578·6	40·5
341	340·2	23·8	401	400·0	28·0	461	459·9	32·2	521	519·7	36·3	581	579·6	40·5
342	341·2	23·9	402	401·0	28·0	462	460·9	32·2	522	520·7	36·4	582	580·6	40·6
343	342·2	23·9	403	402·0	28·1	463	461·9	32·3	523	521·7	36·4	583	581·6	40·7
344	343·1	24·0	404	403·0	28·2	464	462·9	32·4	524	522·7	36·5	584	582·6	40·7
345	344·1	24·1	405	404·0	28·2	465	463·9	32·4	525	523·7	36·6	585	583·6	40·8
346	345·1	24·1	406	405·0	28·3	466	464·9	32·5	526	524·7	36·7	586	584·6	40·9
347	346·1	24·2	407	406·0	28·4	467	465·8	32·6	527	525·7	36·8	587	585·6	40·9
348	347·1	24·3	408	407·0	28·5	468	466·8	32·6	528	526·7	36·8	588	586·6	41·0
349	348·1	24·3	409	408·0	28·5	469	467·8	32·7	529	527·7	36·9	589	587·6	41·1
350	349·1	24·4	410	409·0	28·6	470	468·8	32·8	530	528·7	37·0	590	588·6	41·2
351	350·1	24·5	411	410·0	28·7	471	469·8	32·9	531	529·7	37·0	591	589·6	41·3
352	351·1	24·6	412	411·0	28·7	472	470·8	32·9	532	530·7	37·1	592	590·6	41·3
353	352·1	24·6	413	412·0	28·8	473	471·8	33·0	533	531·7	37·2	593	591·6	41·4
354	353·1	24·7	414	413·0	28·9	474	472·8	33·1	534	532·7	37·2	594	592·6	41·5
355	354·1	24·8	415	414·0	28·9	475	473·8	33·1	535	533·7	37·3	595	593·6	41·5
356	355·1	24·8	416	415·0	29·0	476	474·8	33·2	536	534·7	37·4	596	594·6	41·6
357	356·1	24·9	417	416·0	29·1	477	475·8	33·3	537	535·7	37·5	597	595·6	41·7
358	357·1	25·0	418	417·0	29·2	478	476·8	33·3	538	536·7	37·5	598	596·6	41·7
359	358·1	25·0	419	418·0	29·2	479	477·8	33·4	539	537·7	37·6	599	597·6	41·8
360	359·1	25·1	420	419·0	29·3	480	478·8	33·5	540	538·7	37·7	600	598·6	41·9
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

86° 5h 44m

TRAVERSE TABLE TO DEGREES

5° — $0^h\ 20^m$

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	1·0	0·1	61	60·8	5·3	121	120·5	10·5	181	180·3	15·8	241	240·1	21·0
2	2·0	0·2	62	61·8	5·4	122	121·5	10·6	182	181·3	15·9	242	241·1	21·1
3	3·0	0·3	63	62·8	5·5	123	122·5	10·7	183	182·3	15·9	243	242·1	21·2
4	4·0	0·3	64	63·8	5·6	124	123·5	10·8	184	183·3	16·0	244	243·1	21·3
5	5·0	0·4	65	64·8	5·7	125	124·5	10·9	185	184·3	16·1	245	244·1	21·4
6	6·0	0·5	66	65·7	5·8	126	125·5	11·0	186	185·3	16·2	246	245·1	21·4
7	7·0	0·6	67	66·7	5·8	127	126·5	11·1	187	186·3	16·3	247	246·1	21·5
8	8·0	0·7	68	67·7	5·9	128	127·5	11·2	188	187·3	16·4	248	247·1	21·6
9	9·0	0·8	69	68·7	6·0	129	128·5	11·2	189	188·3	16·5	249	248·1	21·7
10	10·0	0·9	70	69·7	6·1	130	129·5	11·3	190	189·3	16·6	250	249·0	21·8
11	11·0	1·0	71	70·7	6·2	131	130·5	11·4	191	190·3	16·6	251	250·0	21·9
12	12·0	1·0	72	71·7	6·3	132	131·5	11·5	192	191·3	16·7	252	251·0	22·0
13	13·0	1·1	73	72·7	6·4	133	132·5	11·6	193	192·3	16·8	253	252·0	22·1
14	13·9	1·2	74	73·7	6·4	134	133·5	11·7	194	193·3	16·9	254	253·0	22·1
15	14·9	1·3	75	74·7	6·5	135	134·5	11·8	195	194·3	17·0	255	254·0	22·2
16	15·9	1·4	76	75·7	6·6	136	135·5	11·9	196	195·3	17·1	256	255·0	22·3
17	16·9	1·5	77	76·7	6·7	137	136·5	11·9	197	196·3	17·2	257	256·0	22·4
18	17·9	1·6	78	77·7	6·8	138	137·5	12·0	198	197·2	17·3	258	257·0	22·5
19	18·9	1·7	79	78·7	6·9	139	138·5	12·1	199	198·2	17·3	259	258·0	22·6
20	19·9	1·7	80	79·7	7·0	140	139·5	12·2	200	199·2	17·4	260	259·0	22·7
21	20·9	1·8	81	80·7	7·1	141	140·5	12·3	201	200·2	17·5	261	260·0	22·7
22	21·9	1·9	82	81·7	7·1	142	141·5	12·4	202	201·2	17·6	262	261·0	22·8
23	22·9	2·0	83	82·7	7·2	143	142·5	12·5	203	202·2	17·7	263	262·0	22·9
24	23·9	2·1	84	83·7	7·3	144	143·5	12·6	204	203·2	17·8	264	263·0	23·0
25	24·9	2·2	85	84·7	7·4	145	144·4	12·6	205	204·2	17·9	265	264·0	23·1
26	25·9	2·3	86	85·7	7·5	146	145·4	12·7	206	205·2	18·0	266	265·0	23·2
27	26·9	2·4	87	86·7	7·6	147	146·4	12·8	207	206·2	18·0	267	266·0	23·3
28	27·9	2·4	88	87·7	7·7	148	147·4	12·9	208	207·2	18·1	268	267·0	23·4
29	28·9	2·5	89	88·7	7·8	149	148·4	13·0	209	208·2	18·2	269	268·0	23·4
30	29·9	2·6	90	89·7	7·8	150	149·4	13·1	210	209·2	18·3	270	269·0	23·5
31	30·9	2·7	91	90·7	7·9	151	150·4	13·2	211	210·2	18·4	271	270·0	23·6
32	31·9	2·8	92	91·6	8·0	152	151·4	13·2	212	211·2	18·5	272	271·0	23·7
33	32·9	2·9	93	92·6	8·1	153	152·4	13·3	213	212·2	18·6	273	272·0	23·8
34	33·9	3·0	94	93·6	8·2	154	153·4	13·4	214	213·2	18·7	274	273·0	23·9
35	34·9	3·1	95	94·6	8·3	155	154·4	13·5	215	214·2	18·7	275	274·0	24·0
36	35·9	3·1	96	95·6	8·4	156	155·4	13·6	216	215·2	18·8	276	274·9	24·1
37	36·9	3·2	97	96·6	8·5	157	156·4	13·7	217	216·2	18·9	277	275·9	24·1
38	37·9	3·3	98	97·6	8·5	158	157·4	13·8	218	217·2	19·0	278	276·9	24·2
39	38·9	3·4	99	98·6	8·6	159	158·4	13·9	219	218·2	19·1	279	277·9	24·3
40	39·8	3·5	100	99·6	8·7	160	159·4	13·9	220	219·2	19·2	280	278·9	24·4
41	40·8	3·6	101	100·6	8·8	161	160·4	14·0	221	220·2	19·3	281	279·9	24·5
42	41·8	3·7	102	101·6	8·9	162	161·4	14·1	222	221·2	19·3	282	280·9	24·6
43	42·8	3·7	103	102·6	9·0	163	162·4	14·2	223	222·2	19·4	283	281·9	24·7
44	43·8	3·8	104	103·6	9·1	164	163·4	14·3	224	223·1	19·5	284	282·9	24·8
45	44·8	3·9	105	104·6	9·2	165	164·4	14·4	225	224·1	19·6	285	283·9	24·8
46	45·8	4·0	106	105·6	9·2	166	165·4	14·5	226	225·1	19·7	286	284·9	24·9
47	46·8	4·1	107	106·6	9·3	167	166·4	14·6	227	226·1	19·8	287	285·9	25·0
48	47·8	4·2	108	107·6	9·4	168	167·4	14·6	228	227·1	19·9	288	286·9	25·1
49	48·8	4·3	109	108·6	9·5	169	168·4	14·7	229	228·1	20·0	289	287·9	25·2
50	49·8	4·4	110	109·6	9·6	170	169·4	14·8	230	229·1	20·0	290	288·9	25·3
51	50·8	4·4	111	110·6	9·7	171	170·3	14·9	231	230·1	20·1	291	289·9	25·4
52	51·8	4·5	112	111·6	9·8	172	171·3	15·0	232	231·1	20·2	292	290·9	25·4
53	52·8	4·6	113	112·6	9·8	173	172·3	15·1	233	232·1	20·3	293	291·9	25·5
54	53·8	4·7	114	113·6	9·9	174	173·3	15·2	234	233·1	20·4	294	292·9	25·6
55	54·8	4·8	115	114·6	10·0	175	174·3	15·3	235	234·1	20·5	295	293·9	25·7
56	55·8	4·9	116	115·6	10·1	176	175·3	15·3	236	235·1	20·6	296	294·9	25·8
57	56·8	5·0	117	116·6	10·2	177	176·3	15·4	237	236·1	20·7	297	295·9	25·9
58	57·8	5·1	118	117·6	10·3	178	177·3	15·5	238	237·1	20·7	298	296·9	26·0
59	58·8	5·1	119	118·5	10·4	179	178·3	15·6	239	238·1	20·8	299	297·9	26·1
60	59·8	5·2	120	119·5	10·5	180	179·3	15·7	240	239·1	20·9	300	298·9	26·1
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

85° — $5^h\ 40^m$

TRAVERSE TABLE TO DEGREES

5° 0h 20m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	299·9	26·2	361	359·6	31·5	421	419·4	36·7	481	479·2	41·9	541	538·9	47·2
302	300·8	26·3	362	360·6	31·6	422	420·4	36·8	482	480·2	42·0	542	539·9	47·3
303	301·8	26·4	363	361·6	31·6	423	421·4	36·9	483	481·2	42·1	543	540·9	47·4
304	302·8	26·5	364	362·6	31·7	424	422·4	37·0	484	482·2	42·2	544	541·9	47·5
305	303·8	26·6	365	363·6	31·8	425	423·4	37·1	485	483·2	42·3	545	542·9	47·6
306	304·8	26·7	366	364·6	31·9	426	424·4	37·1	486	484·1	42·4	546	543·9	47·7
307	305·8	26·8	367	365·6	32·0	427	425·4	37·2	487	485·1	42·4	547	544·9	47·7
308	306·8	26·9	368	366·6	32·1	428	426·4	37·3	488	486·1	42·5	548	545·9	47·8
309	307·8	26·9	369	367·6	32·2	429	427·4	37·4	489	487·1	42·6	549	546·9	47·9
310	308·8	27·0	370	368·6	32·3	430	428·4	37·5	490	488·1	42·7	550	547·9	48·0
311	309·8	27·1	371	369·6	32·3	431	429·4	37·6	491	489·1	42·8	551	548·9	48·1
312	310·8	27·2	372	370·6	32·4	432	430·4	37·7	492	490·1	42·9	552	549·9	48·2
313	311·8	27·3	373	371·6	32·5	433	431·3	37·7	493	491·1	43·0	553	550·9	48·3
314	312·8	27·4	374	372·6	32·6	434	432·3	37·8	494	492·1	43·1	554	551·9	48·4
315	313·8	27·5	375	373·6	32·7	435	433·3	37·9	495	493·1	43·1	555	552·9	48·4
316	314·8	27·5	376	374·6	32·8	436	434·3	38·0	496	494·1	43·2	556	553·9	48·5
317	315·8	27·6	377	375·6	32·9	437	435·3	38·1	497	495·1	43·3	557	554·9	48·6
318	316·8	27·7	378	376·6	33·0	438	436·3	38·2	498	496·1	43·4	558	555·9	48·7
319	317·8	27·8	379	377·6	33·0	439	437·3	38·3	499	497·1	43·5	559	556·9	48·8
320	318·8	27·9	380	378·6	33·1	440	438·3	38·4	500	498·1	43·6	560	557·9	48·8
321	319·8	28·0	381	379·5	33·2	441	439·3	38·4	501	499·1	43·7	561	558·8	48·9
322	320·8	28·1	382	380·5	33·3	442	440·3	38·5	502	500·1	43·8	562	559·8	49·0
323	321·8	28·2	383	381·5	33·4	443	441·3	38·6	503	501·1	43·8	563	560·8	49·1
324	322·8	28·2	384	382·5	33·5	444	442·3	38·7	504	502·1	43·9	564	561·8	49·2
325	323·8	28·3	385	383·5	33·6	445	443·3	38·8	505	503·1	44·0	565	562·8	49·3
326	324·8	28·4	386	384·5	33·7	446	444·3	38·9	506	504·1	44·1	566	563·8	49·4
327	325·8	28·5	387	385·5	33·7	447	445·3	39·0	507	505·1	44·2	567	564·8	49·5
328	326·7	28·6	388	386·5	33·8	448	446·3	39·1	508	506·1	44·3	568	565·8	49·6
329	327·7	28·7	389	387·5	33·9	449	447·3	39·1	509	507·1	44·4	569	566·8	49·7
330	328·7	28·8	390	388·5	34·0	450	448·3	39·2	510	508·1	44·5	570	567·8	49·7
331	329·7	28·9	391	389·5	34·1	451	449·3	39·3	511	509·0	44·5	571	568·8	49·8
332	330·7	28·9	392	390·5	34·2	452	450·3	39·4	512	510·0	44·6	572	569·8	49·9
333	331·7	29·0	393	391·5	34·3	453	451·3	39·5	513	511·0	44·7	573	570·8	50·0
334	332·7	29·1	394	392·5	34·3	454	452·3	39·6	514	512·0	44·8	574	571·8	50·1
335	333·7	29·2	395	393·5	34·4	455	453·3	39·7	515	513·0	44·9	575	572·8	50·2
336	334·7	29·3	396	394·5	34·5	456	454·3	39·8	516	514·0	45·0	576	573·8	50·3
337	335·7	29·4	397	395·5	34·6	457	455·3	39·8	517	515·0	45·1	577	574·8	50·4
338	336·7	29·5	398	396·5	34·7	458	456·3	39·9	518	516·0	45·2	578	575·8	50·4
339	337·7	29·6	399	397·5	34·8	459	457·3	40·0	519	517·0	45·2	579	576·8	50·5
340	338·7	29·6	400	398·5	34·9	460	458·2	40·1	520	518·0	45·3	580	577·8	50·6
341	339·7	29·7	401	399·5	35·0	461	459·2	40·2	521	519·0	45·4	581	578·8	50·7
342	340·7	29·8	402	400·5	35·0	462	460·2	40·3	522	520·0	45·5	582	579·8	50·8
343	341·7	29·9	403	401·5	35·1	463	461·2	40·4	523	521·0	45·6	583	580·8	50·9
344	342·7	30·0	404	402·5	35·2	464	462·2	40·4	524	522·0	45·7	584	581·8	50·9
345	343·7	30·1	405	403·5	35·3	465	463·2	40·5	525	523·0	45·8	585	582·8	51·0
346	344·7	30·2	406	404·5	35·4	466	464·2	40·6	526	524·0	45·9	586	583·8	51·1
347	345·7	30·3	407	405·4	35·5	467	465·2	40·7	527	525·0	45·9	587	584·8	51·2
348	346·7	30·3	408	406·4	35·6	468	466·2	40·8	528	526·0	46·0	588	585·8	51·3
349	347·7	30·4	409	407·4	35·7	469	467·2	40·9	529	527·0	46·1	589	586·8	51·4
350	348·7	30·5	410	408·4	35·7	470	468·2	41·0	530	528·0	46·2	590	587·8	51·5
351	349·7	30·6	411	409·4	35·8	471	469·2	41·1	531	529·0	46·3	591	588·7	51·6
352	350·7	30·7	412	410·4	35·9	472	470·2	41·1	532	530·0	46·4	592	589·7	51·6
353	351·7	30·8	413	411·4	36·0	473	471·2	41·2	533	531·0	46·5	593	590·7	51·7
354	352·6	30·9	414	412·4	36·1	474	472·2	41·3	534	532·0	46·6	594	591·7	51·8
355	353·6	30·9	415	413·4	36·2	475	473·2	41·4	535	533·0	46·6	595	592·7	51·9
356	354·6	31·0	416	414·4	36·3	476	474·2	41·5	536	533·9	46·7	596	593·7	52·0
357	355·6	31·1	417	415·4	36·4	477	475·2	41·6	537	534·9	46·8	597	594·7	52·1
358	356·6	31·2	418	416·4	36·4	478	476·2	41·7	538	535·9	46·9	598	595·7	52·2
359	357·6	31·3	419	417·4	36·5	479	477·2	41·8	539	536·9	47·0	599	596·7	52·3
360	358·6	31·4	420	418·4	36·6	480	478·2	41·8	540	537·9	47·1	600	597·7	52·3
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

85° 5h 40m

TRAVERSE TABLE TO DEGREES

6° — 0ʰ 24ᵐ

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	1·0	0·1	61	60·7	6·4	121	120·3	12·6	181	180·0	18·9	241	239·7	25·2
2	2·0	0·2	62	61·7	6·5	122	121·3	12·8	182	181·0	19·0	242	240·7	25·3
3	3·0	0·3	63	62·7	6·6	123	122·3	12·9	183	182·0	19·1	243	241·7	25·4
4	4·0	0·4	64	63·6	6·7	124	123·3	13·0	184	183·0	19·2	244	242·7	25·5
5	5·0	0·5	65	64·6	6·8	125	124·3	13·1	185	184·0	19·3	245	243·7	25·6
6	6·0	0·6	66	65·6	6·9	126	125·3	13·2	186	185·0	19·4	246	244·7	25·7
7	7·0	0·7	67	66·6	7·0	127	126·3	13·3	187	186·0	19·5	247	245·6	25·8
8	8·0	0·8	68	67·6	7·1	128	127·3	13·4	188	187·0	19·7	248	246·6	25·9
9	9·0	0·9	69	68·6	7·2	129	128·3	13·5	189	188·0	19·8	249	247·6	26·0
10	9·9	1·0	70	69·6	7·3	130	129·3	13·6	190	189·0	19·9	250	248·6	26·1
11	10·9	1·1	71	70·6	7·4	131	130·3	13·7	191	190·0	20·0	251	249·6	26·2
12	11·9	1·3	72	71·6	7·5	132	131·3	13·8	192	190·9	20·1	252	250·6	26·3
13	12·9	1·4	73	72·6	7·6	133	132·3	13·9	193	191·9	20·2	253	251·6	26·4
14	13·9	1·5	74	73·6	7·7	134	133·3	14·0	194	192·9	20·3	254	252·6	26·6
15	14·9	1·6	75	74·6	7·8	135	134·3	14·1	195	193·9	20·4	255	253·6	26·7
16	15·9	1·7	76	75·6	7·9	136	135·3	14·2	196	194·9	20·5	256	254·6	26·8
17	16·9	1·8	77	76·6	8·0	137	136·2	14·3	197	195·9	20·6	257	255·6	26·9
18	17·9	1·9	78	77·6	8·2	138	137·2	14·4	198	196·9	20·7	258	256·6	27·0
19	18·9	2·0	79	78·6	8·3	139	138·2	14·5	199	197·9	20·8	259	257·6	27·1
20	19·9	2·1	80	79·6	8·4	140	139·2	14·6	200	198·9	20·9	260	258·6	27·2
21	20·9	2·2	81	80·6	8·5	141	140·2	14·7	201	199·9	21·0	261	259·6	27·3
22	21·9	2·3	82	81·6	8·6	142	141·2	14·8	202	200·9	21·1	262	260·6	27·4
23	22·9	2·4	83	82·5	8·7	143	142·2	14·9	203	201·9	21·2	263	261·6	27·5
24	23·9	2·5	84	83·5	8·8	144	143·2	15·0	204	202·9	21·3	264	262·6	27·6
25	24·9	2·6	85	84·5	8·9	145	144·2	15·1	205	203·9	21·4	265	263·5	27·7
26	25·9	2·7	86	85·5	9·0	146	145·2	15·3	206	204·9	21·5	266	264·5	27·8
27	26·9	2·8	87	86·5	9·1	147	146·2	15·4	207	205·9	21·6	267	265·5	27·9
28	27·8	2·9	88	87·5	9·2	148	147·2	15·5	208	206·9	21·7	268	266·5	28·0
29	28·8	3·0	89	88·5	9·3	149	148·2	15·6	209	207·9	21·8	269	267·5	28·1
30	29·8	3·1	90	89·5	9·4	150	149·2	15·7	210	208·8	22·0	270	268·5	28·2
31	30·8	3·2	91	90·5	9·5	151	150·2	15·8	211	209·8	22·1	271	269·5	28·3
32	31·8	3·3	92	91·5	9·6	152	151·2	15·9	212	210·8	22·2	272	270·5	28·4
33	32·8	3·4	93	92·5	9·7	153	152·2	16·0	213	211·8	22·3	273	271·5	28·5
34	33·8	3·6	94	93·5	9·8	154	153·2	16·1	214	212·8	22·4	274	272·5	28·6
35	34·8	3·7	95	94·5	9·9	155	154·2	16·2	215	213·8	22·5	275	273·5	28·7
36	35·8	3·8	96	95·5	10·0	156	155·1	16·3	216	214·8	22·6	276	274·5	28·8
37	36·8	3·9	97	96·5	10·1	157	156·1	16·4	217	215·8	22·7	277	275·5	29·0
38	37·8	4·0	98	97·5	10·2	158	157·1	16·5	218	216·8	22·8	278	276·5	29·1
39	38·8	4·1	99	98·5	10·3	159	158·1	16·6	219	217·8	22·9	279	277·5	29·2
40	39·8	4·2	100	99·5	10·5	160	159·1	16·7	220	218·8	23·0	280	278·5	29·3
41	40·8	4·3	101	100·4	10·6	161	160·1	16·8	221	219·8	23·1	281	279·5	29·4
42	41·8	4·4	102	101·4	10·7	162	161·1	16·9	222	220·8	23·2	282	280·5	29·5
43	42·8	4·5	103	102·4	10·8	163	162·1	17·0	223	221·8	23·3	283	281·4	29·6
44	43·8	4·6	104	103·4	10·9	164	163·1	17·1	224	222·8	23·4	284	282·4	29·7
45	44·8	4·7	105	104·4	11·0	165	164·1	17·2	225	223·8	23·5	285	283·4	29·8
46	45·7	4·8	106	105·4	11·1	166	165·1	17·4	226	224·8	23·6	286	284·4	29·9
47	46·7	4·9	107	106·4	11·2	167	166·1	17·5	227	225·8	23·7	287	285·4	30·0
48	47·7	5·0	108	107·4	11·3	168	167·1	17·6	228	226·8	23·8	288	286·4	30·1
49	48·7	5·1	109	108·4	11·4	169	168·1	17·7	229	227·7	23·9	289	287·4	30·2
50	49·7	5·2	110	109·4	11·5	170	169·1	17·8	230	228·7	24·0	290	288·4	30·3
51	50·7	5·3	111	110·4	11·6	171	170·1	17·9	231	229·7	24·1	291	289·4	30·4
52	51·7	5·4	112	111·4	11·7	172	171·1	18·0	232	230·7	24·3	292	290·4	30·5
53	52·7	5·5	113	112·4	11·8	173	172·1	18·1	233	231·7	24·4	293	291·4	30·6
54	53·7	5·6	114	113·4	11·9	174	173·0	18·2	234	232·7	24·5	294	292·4	30·7
55	54·7	5·7	115	114·4	12·0	175	174·0	18·3	235	233·7	24·6	295	293·4	30·8
56	55·7	5·9	116	115·4	12·1	176	175·0	18·4	236	234·7	24·7	296	294·4	30·9
57	56·7	6·0	117	116·4	12·2	177	176·0	18·5	237	235·7	24·8	297	295·4	31·0
58	57·7	6·1	118	117·4	12·3	178	177·0	18·6	238	236·7	24·9	298	296·4	31·1
59	58·7	6·2	119	118·3	12·4	179	178·0	18·7	239	237·7	25·0	299	297·4	31·3
60	59·7	6·3	120	119·3	12·5	180	179·0	18·8	240	238·7	25·1	300	298·4	31·4
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

84° — 5ʰ 36ᵐ

TRAVERSE TABLE TO DEGREES

6° — $0^h\ 24^m$

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	299·3	31·5	361	359·0	37·7	421	418·7	44·0	481	478·4	50·3	541	538·0	56·5
302	300·3	31·6	362	360·0	37·8	422	419·7	44·1	482	479·4	50·4	542	539·0	56·6
303	301·3	31·7	363	361·0	37·9	423	420·7	44·2	483	480·4	50·5	543	540·0	56·7
304	302·3	31·8	364	362·0	38·0	424	421·7	44·3	484	481·3	50·6	544	541·0	56·8
305	303·3	31·9	365	363·0	38·1	425	422·7	44·4	485	482·3	50·7	545	542·0	56·9
306	304·3	32·0	366	364·0	38·3	426	423·7	44·5	486	483·3	50·8	546	543·0	57·0
307	305·3	32·1	367	365·0	38·4	427	424·7	44·6	487	484·3	50·9	547	544·0	57·1
308	306·3	32·2	368	366·0	38·5	428	425·7	44·7	488	485·3	51·0	548	545·0	57·2
309	307·3	32·3	369	367·0	38·6	429	426·6	44·8	489	486·3	51·1	549	546·0	57·3
310	308·3	32·4	370	368·0	38·7	430	427·6	44·9	490	487·3	51·2	550	547·0	57·4
311	309·3	32·5	371	369·0	38·8	431	428·6	45·0	491	488·3	51·3	551	548·0	57·5
312	310·3	32·6	372	370·0	38·9	432	429·6	45·2	492	489·3	51·4	552	549·0	57·6
313	311·3	32·7	373	371·0	39·0	433	430·6	45·3	493	490·3	51·5	553	550·0	57·7
314	312·3	32·8	374	371·9	39·1	434	431·6	45·4	494	491·3	51·6	554	551·0	57·9
315	313·3	32·9	375	372·9	39·2	435	432·6	45·5	495	492·3	51·7	555	552·0	58·0
316	314·3	33·0	376	373·9	39·3	436	433·6	45·6	496	493·3	51·8	556	553·0	58·1
317	315·3	33·1	377	374·9	39·4	437	434·6	45·7	497	494·3	51·9	557	554·0	58·2
318	316·3	33·2	378	375·9	39·5	438	435·6	45·8	498	495·3	52·0	558	555·0	58·3
319	317·3	33·3	379	376·9	39·6	439	436·6	45·9	499	496·3	52·1	559	556·0	58·4
320	318·2	33·4	380	377·9	39·7	440	437·6	46·0	500	497·3	52·3	560	556·9	58·5
321	319·2	33·6	381	378·9	39·8	441	438·6	46·1	501	498·3	52·4	561	557·9	58·6
322	320·2	33·7	382	379·9	39·9	442	439·6	46·2	502	499·3	52·5	562	558·9	58·7
323	321·2	33·8	383	380·9	40·0	443	440·6	46·3	503	500·2	52·6	563	559·9	58·8
324	322·2	33·9	384	381·9	40·1	444	441·6	46·4	504	501·2	52·7	564	560·9	59·0
325	323·2	34·0	385	382·9	40·2	445	442·6	46·5	505	502·2	52·8	565	561·9	59·1
326	324·2	34·1	386	383·9	40·3	446	443·6	46·6	506	503·2	52·9	566	562·9	59·2
327	325·2	34·2	387	384·9	40·5	447	444·5	46·7	507	504·2	53·0	567	563·9	59·3
328	326·2	34·3	388	385·9	40·6	448	445·5	46·8	508	505·2	53·1	568	564·9	59·4
329	327·2	34·4	389	386·9	40·7	449	446·5	46·9	509	506·2	53·2	569	565·9	59·5
330	328·2	34·5	390	387·9	40·8	450	447·5	47·0	510	507·2	53·3	570	566·9	59·6
331	329·2	34·6	391	388·9	40·9	451	448·5	47·1	511	508·2	53·4	571	567·9	59·7
332	330·2	34·7	392	389·9	41·0	452	449·5	47·2	512	509·2	53·5	572	568·9	59·8
333	331·2	34·8	393	390·8	41·1	453	450·5	47·3	513	510·2	53·6	573	569·9	59·9
334	332·2	34·9	394	391·8	41·2	454	451·5	47·5	514	511·2	53·7	574	570·9	60·0
335	333·2	35·0	395	392·8	41·3	455	452·5	47·6	515	512·2	53·8	575	571·9	60·1
336	334·2	35·1	396	393·8	41·4	456	453·5	47·7	516	513·2	53·9	576	572·9	60·2
337	335·2	35·2	397	394·8	41·5	457	454·5	47·8	517	514·2	54·0	577	573·9	60·3
338	336·1	35·3	398	395·8	41·6	458	455·5	47·9	518	515·2	54·1	578	574·9	60·4
339	337·1	35·4	399	396·8	41·7	459	456·5	48·0	519	516·2	54·2	579	575·8	60·5
340	338·1	35·5	400	397·8	41·8	460	457·5	48·1	520	517·2	54·3	580	576·8	60·6
341	339·1	35·6	401	398·8	41·9	461	458·5	48·2	521	518·1	54·5	581	577·8	60·7
342	340·1	35·7	402	399·8	42·0	462	459·5	48·3	522	519·1	54·6	582	578·8	60·8
343	341·1	35·8	403	400·8	42·1	463	460·5	48·4	523	520·1	54·7	583	579·8	60·9
344	342·1	36·0	404	401·8	42·2	464	461·5	48·5	524	521·1	54·8	584	580·8	61·1
345	343·1	36·1	405	402·8	42·3	465	462·5	48·6	525	522·1	54·9	585	581·8	61·2
346	344·1	36·2	406	403·8	42·4	466	463·4	48·7	526	523·1	55·0	586	582·8	61·3
347	345·1	36·3	407	404·8	42·5	467	464·4	48·8	527	524·1	55·1	587	583·8	61·4
348	346·1	36·4	408	405·8	42·6	468	465·4	48·9	528	525·1	55·2	588	584·8	61·5
349	347·1	36·5	409	406·8	42·7	469	466·4	49·0	529	526·1	55·3	589	585·8	61·6
350	348·1	36·6	410	407·8	42·9	470	467·4	49·1	530	527·1	55·4	590	586·8	61·7
351	349·1	36·7	411	408·7	43·0	471	468·4	49·2	531	528·1	55·5	591	587·8	61·8
352	350·1	36·8	412	409·7	43·1	472	469·4	49·3	532	529·1	55·6	592	588·8	61·9
353	351·1	36·9	413	410·7	43·2	473	470·4	49·4	533	530·1	55·7	593	589·8	62·0
354	352·1	37·0	414	411·7	43·3	474	471·4	49·5	534	531·1	55·8	594	590·8	62·1
355	353·1	37·1	415	412·7	43·4	475	472·4	49·6	535	532·1	55·9	595	591·8	62·2
356	354·0	37·2	416	413·7	43·5	476	473·4	49·8	536	533·1	56·0	596	592·8	62·3
357	355·0	37·3	417	414·7	43·6	477	474·4	49·9	537	534·1	56·1	597	593·8	62·4
358	356·0	37·4	418	415·7	43·7	478	475·4	50·0	538	535·1	56·2	598	594·7	62·5
359	357·0	37·5	419	416·7	43·8	479	476·4	50·1	539	536·1	56·3	599	595·7	62·6
360	358·0	37·6	420	417·7	43·9	480	477·4	50·2	540	537·1	56·4	600	596·7	62·7
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

81° — $5^h\ 36^m$

TRAVERSE TABLE TO DEGREES

7° 0h 28m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	1·0	0·1	61	60·5	7·4	121	120·1	14·7	181	179·7	22·1	241	239·2	29·4
2	2·0	0·2	62	61·5	7·6	122	121·1	14·9	182	180·6	22·2	242	240·2	29·5
3	3·0	0·4	63	62·5	7·7	123	122·1	15·0	183	181·6	22·3	243	241·2	29·6
4	4·0	0·5	64	63·5	7·8	124	123·1	15·1	184	182·6	22·4	244	242·2	29·7
5	5·0	0·6	65	64·5	7·9	125	124·1	15·2	185	183·6	22·5	245	243·2	29·9
6	6·0	0·7	66	65·5	8·0	126	125·1	15·4	186	184·6	22·7	246	244·2	30·0
7	6·9	0·9	67	66·5	8·2	127	126·1	15·5	187	185·6	22·8	247	245·2	30·1
8	7·9	1·0	68	67·5	8·3	128	127·0	15·6	188	186·6	22·9	248	246·2	30·2
9	8·9	1·1	69	68·5	8·4	129	128·0	15·7	189	187·6	23·0	249	247·1	30·3
10	9·9	1·2	70	69·5	8·5	130	129·0	15·8	190	188·6	23·2	250	248·1	30·5
11	10·9	1·3	71	70·5	8·7	131	130·0	16·0	191	189·6	23·3	251	249·1	30·6
12	11·9	1·5	72	71·5	8·8	132	131·0	16·1	192	190·6	23·4	252	250·1	30·7
13	12·9	1·6	73	72·5	8·9	133	132·0	16·2	193	191·6	23·5	253	251·1	30·8
14	13·9	1·7	74	73·4	9·0	134	133·0	16·3	194	192·6	23·6	254	252·1	31·0
15	14·9	1·8	75	74·4	9·1	135	134·0	16·5	195	193·5	23·8	255	253·1	31·1
16	15·9	1·9	76	75·4	9·3	136	135·0	16·6	196	194·5	23·9	256	254·1	31·2
17	16·9	2·1	77	76·4	9·4	137	136·0	16·7	197	195·5	24·0	257	255·1	31·3
18	17·9	2·2	78	77·4	9·5	138	137·0	16·8	198	196·5	24·1	258	256·1	31·4
19	18·9	2·3	79	78·4	9·6	139	138·0	16·9	199	197·5	24·3	259	257·1	31·6
20	19·9	2·4	80	79·4	9·7	140	139·0	17·1	200	198·5	24·4	260	258·1	31·7
21	20·8	2·6	81	80·4	9·9	141	139·9	17·2	201	199·5	24·5	261	259·1	31·8
22	21·8	2·7	82	81·4	10·0	142	140·9	17·3	202	200·5	24·6	262	260·0	31·9
23	22·8	2·8	83	82·4	10·1	143	141·9	17·4	203	201·5	24·7	263	261·0	32·1
24	23·8	2·9	84	83·4	10·2	144	142·9	17·5	204	202·5	24·9	264	262·0	32·2
25	24·8	3·0	85	84·4	10·4	145	143·9	17·7	205	203·5	25·0	265	263·0	32·3
26	25·8	3·2	86	85·4	10·5	146	144·9	17·8	206	204·5	25·1	266	264·0	32·4
27	26·8	3·3	87	86·4	10·6	147	145·9	17·9	207	205·5	25·2	267	265·0	32·5
28	27·8	3·4	88	87·3	10·7	148	146·9	18·0	208	206·4	25·3	268	266·0	32·7
29	28·8	3·5	89	88·3	10·8	149	147·9	18·2	209	207·4	25·5	269	267·0	32·8
30	29·8	3·7	90	89·3	11·0	150	148·9	18·3	210	208·4	25·6	270	268·0	32·9
31	30·8	3·8	91	90·3	11·1	151	149·9	18·4	211	209·4	25·7	271	269·0	33·0
32	31·8	3·9	92	91·3	11·2	152	150·9	18·5	212	210·4	25·8	272	270·0	33·1
33	32·8	4·0	93	92·3	11·3	153	151·9	18·6	213	211·4	26·0	273	271·0	33·3
34	33·7	4·1	94	93·3	11·5	154	152·9	18·8	214	212·4	26·1	274	272·0	33·4
35	34·7	4·3	95	94·3	11·6	155	153·8	18·9	215	213·4	26·2	275	273·0	33·5
36	35·7	4·4	96	95·3	11·7	156	154·8	19·0	216	214·4	26·3	276	273·9	33·6
37	36·7	4·5	97	96·3	11·8	157	155·8	19·1	217	215·4	26·4	277	274·9	33·8
38	37·7	4·6	98	97·3	11·9	158	156·8	19·3	218	216·4	26·6	278	275·9	33·9
39	38·7	4·8	99	98·3	12·1	159	157·8	19·4	219	217·4	26·7	279	276·9	34·0
40	39·7	4·9	100	99·3	12·2	160	158·8	19·5	220	218·4	26·8	280	277·9	34·1
41	40·7	5·0	101	100·2	12·3	161	159·8	19·6	221	219·4	26·9	281	278·9	34·2
42	41·7	5·1	102	101·2	12·4	162	160·8	19·7	222	220·3	27·1	282	279·9	34·4
43	42·7	5·2	103	102·2	12·6	163	161·8	19·9	223	221·3	27·2	283	280·9	34·5
44	43·7	5·4	104	103·2	12·7	164	162·8	20·0	224	222·3	27·3	284	281·9	34·6
45	44·7	5·5	105	104·2	12·8	165	163·8	20·1	225	223·3	27·4	285	282·9	34·7
46	45·7	5·6	106	105·2	12·9	166	164·8	20·2	226	224·3	27·5	286	283·9	34·9
47	46·6	5·7	107	106·2	13·0	167	165·8	20·4	227	225·3	27·7	287	284·9	35·0
48	47·6	5·8	108	107·2	13·2	168	166·7	20·5	228	226·3	27·8	288	285·9	35·1
49	48·6	6·0	109	108·2	13·3	169	167·7	20·6	229	227·3	27·9	289	286·8	35·2
50	49·6	6·1	110	109·2	13·4	170	168·7	20·7	230	228·3	28·0	290	287·8	35·3
51	50·6	6·2	111	110·2	13·5	171	169·7	20·8	231	229·3	28·2	291	288·8	35·5
52	51·6	6·3	112	111·2	13·6	172	170·7	21·0	232	230·3	28·3	292	289·8	35·6
53	52·6	6·5	113	112·2	13·8	173	171·7	21·1	233	231·3	28·4	293	290·8	35·7
54	53·6	6·6	114	113·2	13·9	174	172·7	21·2	234	232·3	28·5	294	291·8	35·8
55	54·6	6·7	115	114·1	14·0	175	173·7	21·3	235	233·2	28·6	295	292·8	36·0
56	55·6	6·8	116	115·1	14·1	176	174·7	21·4	236	234·2	28·8	296	293·8	36·1
57	56·6	6·9	117	116·1	14·3	177	175·7	21·6	237	235·2	28·9	297	294·8	36·2
58	57·6	7·1	118	117·1	14·4	178	176·7	21·7	238	236·2	29·0	298	295·8	36·3
59	58·6	7·2	119	118·1	14·5	179	177·7	21·8	239	237·2	29·1	299	296·8	36·4
60	59·6	7·3	120	119·1	14·6	180	178·7	21·9	240	238·2	29·2	300	297·8	36·6
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

83° 5h 32m

TRAVERSE TABLE TO DEGREES

7° $0^h 28^m$

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	298·7	36·7	361	358·3	44·0	421	417·9	51·3	481	477·4	58·6	541	537·0	65·9
302	299·7	36·8	362	359·3	44·1	422	418·8	51·4	482	478·4	58·7	542	537·9	66·0
303	300·7	36·9	363	360·3	44·2	423	419·8	51·5	483	479·4	58·8	543	538·9	66·2
304	301·7	37·0	364	361·3	44·4	424	420·8	51·7	484	480·4	59·0	544	539·9	66·3
305	302·7	37·2	365	362·3	44·5	425	421·8	51·8	485	481·4	59·1	545	540·9	66·4
306	303·7	37·3	366	363·3	44·6	426	422·8	51·9	486	482·4	59·2	546	541·9	66·6
307	304·7	37·4	367	364·3	44·7	427	423·8	52·0	487	483·4	59·4	547	542·9	66·7
308	305·7	37·5	368	365·2	44·8	428	424·8	52·2	488	484·3	59·5	548	543·9	66·8
309	306·7	37·7	369	366·2	45·0	429	425·8	52·3	489	485·3	59·6	549	544·9	66·9
310	307·7	37·8	370	367·2	45·1	430	426·8	52·4	490	486·3	59·7	550	545·9	67·0
311	308·7	37·9	371	368·2	45·2	431	427·8	52·5	491	487·3	59·8	551	546·9	67·1
312	309·7	38·0	372	369·2	45·3	432	428·8	52·6	492	488·3	59·9	552	547·9	67·2
313	310·7	38·1	373	370·2	45·5	433	429·8	52·8	493	489·3	60·1	553	548·9	67·4
314	311·7	38·3	374	371·2	45·6	434	430·8	52·9	494	490·3	60·2	554	549·9	67·5
315	312·6	38·4	375	372·2	45·7	435	431·7	53·0	495	491·3	60·3	555	550·8	67·6
316	313·6	38·5	376	373·2	45·8	436	432·7	53·1	496	492·3	60·5	556	551·8	67·8
317	314·6	38·6	377	374·2	45·9	437	433·7	53·3	497	493·3	60·6	557	552·8	67·9
318	315·6	38·7	378	375·2	46·1	438	434·7	53·4	498	494·3	60·7	558	553·8	68·0
319	316·6	38·9	379	376·2	46·2	439	435·7	53·5	499	495·3	60·8	559	554·8	68·1
320	317·6	39·0	380	377·2	46·3	440	436·7	53·6	500	496·3	61·0	560	555·8	68·3
321	318·6	39·1	381	378·1	46·4	441	437·7	53·7	501	497·2	61·1	561	556·8	68·4
322	319·6	39·2	382	379·1	46·5	442	438·7	53·9	502	498·2	61·2	562	557·8	68·5
323	320·6	39·4	383	380·1	46·7	443	439·7	54·0	503	499·2	61·3	563	558·8	68·6
324	321·6	39·5	384	381·1	46·8	444	440·7	54·1	504	500·2	61·4	564	559·8	68·7
325	322·6	39·6	385	382·1	46·9	445	441·7	54·2	505	501·2	61·5	565	560·8	68·9
326	323·6	39·7	386	383·1	47·0	446	442·7	54·3	506	502·2	61·6	566	561·8	69·0
327	324·6	39·8	387	384·1	47·2	447	443·7	54·5	507	503·2	61·8	567	562·8	69·1
328	325·5	40·0	388	385·1	47·3	448	444·7	54·6	508	504·2	61·9	568	563·8	69·2
329	326·5	40·1	389	386·1	47·4	449	445·6	54·7	509	505·2	62·0	569	564·8	69·3
330	327·5	40·2	390	387·1	47·5	450	446·6	54·8	510	506·2	62·1	570	565·8	69·4
331	328·5	40·3	391	388·1	47·6	451	447·6	55·0	511	507·2	62·3	571	566·7	69·6
332	329·5	40·5	392	389·1	47·8	452	448·6	55·1	512	508·2	62·4	572	567·7	69·7
333	330·5	40·6	393	390·1	47·9	453	449·6	55·2	513	509·2	62·5	573	568·7	69·8
334	331·5	40·7	394	391·1	48·0	454	450·6	55·3	514	510·2	62·6	574	569·7	69·9
335	332·5	40·8	395	392·0	48·1	455	451·6	55·4	515	511·1	62·7	575	570·7	70·1
336	333·5	40·9	396	393·0	48·3	456	452·6	55·6	516	512·1	62·9	576	571·7	70·2
337	334·5	41·1	397	394·0	48·4	457	453·6	55·7	517	513·1	63·0	577	572·7	70·3
338	335·5	41·2	398	395·0	48·5	458	454·6	55·8	518	514·1	63·1	578	573·7	70·4
339	336·5	41·3	399	396·0	48·6	459	455·6	55·9	519	515·1	63·2	579	574·7	70·5
340	337·5	41·4	400	397·0	48·7	460	456·6	56·1	520	516·1	63·4	580	575·7	70·7
341	338·4	41·6	401	398·0	48·9	461	457·6	56·2	521	517·1	63·5	581	576·7	70·8
342	339·4	41·7	402	399·0	49·0	462	458·5	56·3	522	518·1	63·6	582	577·6	70·9
343	340·4	41·8	403	400·0	49·1	463	459·5	56·4	523	519·1	63·7	583	578·6	71·0
344	341·4	41·9	404	401·0	49·2	464	460·5	56·5	524	520·1	63·8	584	579·6	71·2
345	342·4	42·0	405	402·0	49·4	465	461·5	56·7	525	521·1	64·0	585	580·6	71·3
346	343·4	42·2	406	403·0	49·5	466	462·5	56·8	526	522·1	64·1	586	581·6	71·4
347	344·4	42·3	407	404·0	49·6	467	463·5	56·9	527	523·1	64·2	587	582·6	71·5
348	345·4	42·4	408	405·0	49·7	468	464·5	57·0	528	524·1	64·3	588	583·6	71·6
349	346·4	42·5	409	405·9	49·8	469	465·5	57·2	529	525·0	64·5	589	584·6	71·8
350	347·4	42·6	410	406·9	50·0	470	466·5	57·3	530	526·0	64·6	590	585·6	71·9
351	348·4	42·8	411	407·9	50·1	471	467·5	57·4	531	527·0	64·7	591	586·6	72·0
352	349·4	42·9	412	408·9	50·2	472	468·5	57·5	532	528·0	64·8	592	587·6	72·1
353	350·4	43·0	413	409·9	50·3	473	469·5	57·6	533	529·0	64·9	593	588·6	72·2
354	351·4	43·1	414	410·9	50·4	474	470·5	57·8	534	530·0	65·1	594	589·6	72·4
355	352·3	43·3	415	411·9	50·6	475	471·5	57·9	535	531·0	65·2	595	590·6	72·5
356	353·3	43·4	416	412·9	50·7	476	472·4	58·0	536	532·0	65·3	596	591·5	72·6
357	354·3	43·5	417	413·9	50·8	477	473·4	58·1	537	533·0	65·4	597	592·5	72·7
358	355·3	43·6	418	414·9	50·9	478	474·4	58·2	538	534·0	65·6	598	593·5	72·9
359	356·3	43·7	419	415·9	51·1	479	475·4	58·4	539	535·0	65·7	599	594·5	73·0
360	357·3	43·9	420	416·9	51·2	480	476·4	58·5	540	536·0	65·8	600	595·5	73·1
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

83° $5^h 32^m$

TRAVERSE TABLE TO DEGREES

8° — $0^h\ 32^m$

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	1.0	0.1	61	60.4	8.5	121	119.8	16.8	181	179.2	25.2	241	238.7	33.5
2	2.0	0.3	62	61.4	8.6	122	120.8	17.0	182	180.2	25.3	242	239.6	33.7
3	3.0	0.4	63	62.4	8.8	123	121.8	17.1	183	181.2	25.5	243	240.6	33.8
4	4.0	0.6	64	63.4	8.9	124	122.8	17.3	184	182.2	25.6	244	241.6	34.0
5	5.0	0.7	65	64.4	9.0	125	123.8	17.4	185	183.2	25.7	245	242.6	34.1
6	5.9	0.8	66	65.4	9.2	126	124.8	17.5	186	184.2	25.9	246	243.6	34.2
7	6.9	1.0	67	66.3	9.3	127	125.8	17.7	187	185.2	26.0	247	244.6	34.4
8	7.9	1.1	68	67.3	9.5	128	126.8	17.8	188	186.2	26.2	248	245.6	34.5
9	8.9	1.3	69	68.3	9.6	129	127.7	18.0	189	187.2	26.3	249	246.6	34.7
10	9.9	1.4	70	69.3	9.7	130	128.7	18.1	190	188.2	26.4	250	247.6	34.8
11	10.9	1.5	71	70.3	9.9	131	129.7	18.2	191	189.1	26.6	251	248.6	34.9
12	11.9	1.7	72	71.3	10.0	132	130.7	18.4	192	190.1	26.7	252	249.5	35.1
13	12.9	1.8	73	72.3	10.2	133	131.7	18.5	193	191.1	26.9	253	250.5	35.2
14	13.9	1.9	74	73.3	10.3	134	132.7	18.6	194	192.1	27.0	254	251.5	35.3
15	14.9	2.1	75	74.3	10.4	135	133.7	18.8	195	193.1	27.1	255	252.5	35.5
16	15.8	2.2	76	75.3	10.6	136	134.7	18.9	196	194.1	27.3	256	253.5	35.6
17	16.8	2.4	77	76.3	10.7	137	135.7	19.1	197	195.1	27.4	257	254.5	35.8
18	17.8	2.5	78	77.2	10.9	138	136.7	19.2	198	196.1	27.6	258	255.5	35.9
19	18.8	2.6	79	78.2	11.0	139	137.7	19.3	199	197.1	27.7	259	256.5	36.0
20	19.8	2.8	80	79.2	11.1	140	138.6	19.5	200	198.1	27.8	260	257.5	36.2
21	20.8	2.9	81	80.2	11.3	141	139.6	19.6	201	199.0	28.0	261	258.5	36.3
22	21.8	3.1	82	81.2	11.4	142	140.6	19.8	202	200.0	28.1	262	259.5	36.5
23	22.8	3.2	83	82.2	11.6	143	141.6	19.9	203	201.0	28.3	263	260.4	36.6
24	23.8	3.3	84	83.2	11.7	144	142.6	20.0	204	202.0	28.4	264	261.4	36.7
25	24.8	3.5	85	84.2	11.8	145	143.6	20.2	205	203.0	28.5	265	262.4	36.9
26	25.7	3.6	86	85.2	12.0	146	144.6	20.3	206	204.0	28.7	266	263.4	37.0
27	26.7	3.8	87	86.2	12.1	147	145.6	20.5	207	205.0	28.8	267	264.4	37.2
28	27.7	3.9	88	87.1	12.2	148	146.6	20.6	208	206.0	28.9	268	265.4	37.3
29	28.7	4.0	89	88.1	12.4	149	147.5	20.7	209	207.0	29.1	269	266.4	37.4
30	29.7	4.2	90	89.1	12.5	150	148.5	20.9	210	208.0	29.2	270	267.4	37.6
31	30.7	4.3	91	90.1	12.7	151	149.5	21.0	211	208.9	29.4	271	268.4	37.7
32	31.7	4.5	92	91.1	12.8	152	150.5	21.2	212	209.9	29.5	272	269.4	37.9
33	32.7	4.6	93	92.1	12.9	153	151.5	21.3	213	210.9	29.6	273	270.3	38.0
34	33.7	4.7	94	93.1	13.1	154	152.5	21.4	214	211.9	29.8	274	271.3	38.1
35	34.7	4.9	95	94.1	13.2	155	153.5	21.6	215	212.9	29.9	275	272.3	38.3
36	35.6	5.0	96	95.1	13.4	156	154.5	21.7	216	213.9	30.1	276	273.3	38.4
37	36.6	5.2	97	96.1	13.5	157	155.5	21.9	217	214.9	30.2	277	274.3	38.6
38	37.6	5.3	98	97.0	13.6	158	156.5	22.0	218	215.9	30.3	278	275.3	38.7
39	38.6	5.4	99	98.0	13.8	159	157.5	22.1	219	216.9	30.5	279	276.3	38.8
40	39.6	5.6	100	99.0	13.9	160	158.4	22.3	220	217.9	30.6	280	277.3	39.0
41	40.6	5.7	101	100.0	14.1	161	159.4	22.4	221	218.8	30.8	281	278.3	39.1
42	41.6	5.8	102	101.0	14.2	162	160.4	22.5	222	219.8	30.9	282	279.3	39.2
43	42.6	6.0	103	102.0	14.3	163	161.4	22.7	223	220.8	31.0	283	280.2	39.4
44	43.6	6.1	104	103.0	14.5	164	162.4	22.8	224	221.8	31.2	284	281.2	39.5
45	44.6	6.3	105	104.0	14.6	165	163.4	23.0	225	222.8	31.3	285	282.2	39.7
46	45.6	6.4	106	105.0	14.8	166	164.4	23.1	226	223.8	31.5	286	283.2	39.8
47	46.5	6.5	107	106.0	14.9	167	165.4	23.2	227	224.8	31.6	287	284.2	39.9
48	47.5	6.7	108	107.0	15.0	168	166.4	23.4	228	225.8	31.7	288	285.2	40.1
49	48.5	6.8	109	107.9	15.2	169	167.4	23.5	229	226.8	31.9	289	286.2	40.2
50	49.5	7.0	110	108.9	15.3	170	168.3	23.7	230	227.8	32.0	290	287.2	40.4
51	50.5	7.1	111	109.9	15.4	171	169.3	23.8	231	228.8	32.1	291	288.2	40.5
52	51.5	7.2	112	110.9	15.6	172	170.3	23.9	232	229.7	32.3	292	289.2	40.6
53	52.5	7.4	113	111.9	15.7	173	171.3	24.1	233	230.7	32.4	293	290.1	40.8
54	53.5	7.5	114	112.9	15.9	174	172.3	24.2	234	231.7	32.6	294	291.1	40.9
55	54.5	7.7	115	113.9	16.0	175	173.3	24.4	235	232.7	32.7	295	292.1	41.1
56	55.5	7.8	116	114.9	16.1	176	174.3	24.5	236	233.7	32.8	296	293.1	41.2
57	56.4	7.9	117	115.9	16.3	177	175.3	24.6	237	234.7	33.0	297	294.1	41.3
58	57.4	8.1	118	116.9	16.4	178	176.3	24.8	238	235.7	33.1	298	295.1	41.5
59	58.4	8.2	119	117.8	16.6	179	177.3	24.9	239	236.7	33.3	299	296.1	41.6
60	59.4	8.4	120	118.8	16.7	180	178.2	25.1	240	237.7	33.4	300	297.1	41.8
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

82° — $5^h\ 28^m$

TRAVERSE TABLE TO DEGREES

8° 0h 32m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	298·0	41·9	361	357·5	50·2	421	416·9	58·6	481	476·3	66·9	541	535·7	75·2
302	299·0	42·0	362	358·5	50·4	422	417·9	58·7	482	477·3	67·1	542	536·7	75·4
303	300·0	42·2	363	359·4	50·5	423	418·9	58·9	483	478·3	67·2	543	537·7	75·5
304	301·0	42·3	364	360·4	50·7	424	419·8	59·0	484	479·3	67·4	544	538·7	75·7
305	302·0	42·5	365	361·4	50·8	425	420·8	59·2	485	480·3	67·5	545	539·7	75·8
306	303·0	42·6	366	362·4	50·9	426	421·8	59·3	486	481·2	67·6	546	540·6	75·9
307	304·0	42·7	367	363·4	51·1	427	422·8	59·4	487	482·2	67·8	547	541·6	76·1
308	305·0	42·9	368	364·4	51·2	428	423·8	59·6	488	483·2	67·9	548	542·6	76·2
309	306·0	43·0	369	365·4	51·4	429	424·8	59·7	489	484·2	68·1	549	543·6	76·4
310	307·0	43·1	370	366·4	51·5	430	425·8	59·8	490	485·2	68·2	550	544·6	76·5
311	307·9	43·3	371	367·4	51·6	431	426·8	60·0	491	486·2	68·3	551	545·6	76·6
312	308·9	43·4	372	368·4	51·8	432	427·8	60·1	492	487·2	68·5	552	546·6	76·8
313	309·9	43·6	373	369·3	51·9	433	428·8	60·3	493	488·2	68·6	553	547·6	76·9
314	310·9	43·7	374	370·3	52·1	434	429·8	60·4	494	489·2	68·8	554	548·6	77·1
315	311·9	43·8	375	371·3	52·2	435	430·7	60·5	495	490·2	68·9	555	549·6	77·2
316	312·9	44·0	376	372·3	52·3	436	431·7	60·7	496	491·2	69·0	556	550·6	77·4
317	313·9	44·1	377	373·3	52·5	437	432·7	60·8	497	492·1	69·2	557	551·5	77·5
318	314·9	44·3	378	374·3	52·6	438	433·7	61·0	498	493·1	69·3	558	552·5	77·6
319	315·9	44·4	379	375·3	52·7	439	434·7	61·1	499	494·1	69·5	559	553·5	77·8
320	316·9	44·5	380	376·3	52·9	440	435·7	61·2	500	495·1	69·6	560	554·5	77·9
321	317·9	44·7	381	377·3	53·0	441	436·7	61·4	501	496·1	69·7	561	555·5	78·1
322	318·8	44·8	382	378·3	53·2	442	437·7	61·5	502	497·1	69·9	562	556·5	78·2
323	319·8	45·0	383	379·2	53·3	443	438·7	61·7	503	498·1	70·0	563	557·5	78·3
324	320·8	45·1	384	380·2	53·4	444	439·7	61·8	504	499·1	70·2	564	558·5	78·5
325	321·8	45·2	385	381·2	53·6	445	440·6	61·9	505	500·1	70·3	565	559·5	78·6
326	322·8	45·4	386	382·2	53·7	446	441·6	62·1	506	501·0	70·4	566	560·5	78·8
327	323·8	45·5	387	383·2	53·9	447	442·6	62·2	507	502·0	70·6	567	561·5	78·9
328	324·8	45·7	388	384·2	54·0	448	443·6	62·4	508	503·0	70·7	568	562·5	79·0
329	325·8	45·8	389	385·2	54·1	449	444·6	62·5	509	504·0	70·8	569	563·5	79·1
330	326·8	45·9	390	386·2	54·3	450	445·6	62·6	510	505·0	70·9	570	564·5	79·3
331	327·8	46·1	391	387·2	54·4	451	446·6	62·8	511	506·0	71·1	571	565·4	79·4
332	328·7	46·2	392	388·2	54·6	452	447·6	62·9	512	507·0	71·2	572	566·4	79·6
333	329·7	46·3	393	389·1	54·7	453	448·6	63·0	513	508·0	71·4	573	567·4	79·7
334	330·7	46·5	394	390·1	54·8	454	449·6	63·2	514	509·0	71·5	574	568·4	79·8
335	331·7	46·6	395	391·1	55·0	455	450·5	63·3	515	510·0	71·6	575	569·4	80·0
336	332·7	46·8	396	392·1	55·1	456	451·5	63·5	516	510·9	71·8	576	570·4	80·1
337	333·7	46·9	397	393·1	55·3	457	452·5	63·6	517	511·9	71·9	577	571·4	80·2
338	334·7	47·0	398	394·1	55·4	458	453·5	63·7	518	512·9	72·0	578	572·4	80·4
339	335·7	47·2	399	395·1	55·5	459	454·5	63·9	519	513·9	72·2	579	573·4	80·5
340	336·7	47·3	400	396·1	55·7	460	455·5	64·0	520	514·9	72·3	580	574·4	80·6
341	337·7	47·5	401	397·1	55·8	461	456·5	64·2	521	515·9	72·4	581	575·4	80·8
342	338·6	47·6	402	398·1	56·0	462	457·5	64·3	522	516·9	72·6	582	576·4	80·9
343	339·6	47·7	403	399·1	56·1	463	458·5	64·4	523	517·9	72·8	583	577·4	81·1
344	340·6	47·9	404	400·0	56·2	464	459·5	64·6	524	518·9	73·0	584	578·4	81·3
345	341·6	48·0	405	401·0	56·4	465	460·4	64·7	525	519·9	73·1	585	579·4	81·4
346	342·6	48·2	406	402·0	56·5	466	461·4	64·9	526	520·9	73·2	586	580·3	81·6
347	343·6	48·3	407	403·0	56·6	467	462·4	65·0	527	521·8	73·4	587	581·3	81·7
348	344·6	48·4	408	404·0	56·8	468	463·4	65·1	528	522·8	73·5	588	582·3	81·8
349	345·6	48·6	409	405·0	56·9	469	464·4	65·3	529	523·8	73·7	589	583·3	82·0
350	346·6	48·7	410	406·0	57·1	470	465·4	65·4	530	524·8	73·8	590	584·3	82·1
351	347·6	48·9	411	407·0	57·2	471	466·4	65·6	531	525·8	73·9	591	585·3	82·2
352	348·5	49·0	412	408·0	57·3	472	467·4	65·7	532	526·8	74·1	592	586·3	82·4
353	349·5	49·1	413	409·0	57·5	473	468·4	65·8	533	527·8	74·2	593	587·3	82·5
354	350·5	49·3	414	409·9	57·6	474	469·4	66·0	534	528·8	74·3	594	588·3	82·6
355	351·5	49·4	415	410·9	57·8	475	470·4	66·1	535	529·8	74·5	595	589·3	82·8
356	352·5	49·5	416	411·9	57·9	476	471·3	66·2	536	530·8	74·6	596	590·3	83·0
357	353·5	49·7	417	412·9	58·0	477	472·3	66·4	537	531·7	74·7	597	591·2	83·1
358	354·5	49·8	418	413·9	58·2	478	473·3	66·5	538	532·7	74·9	598	592·2	83·2
359	355·5	50·0	419	414·9	58·3	479	474·3	66·7	539	533·7	75·0	599	593·2	83·3
360	356·5	50·1	420	415·9	58·5	480	475·3	66·8	540	534·7	75·1	600	594·2	83·5
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

82° 5h 28m

TRAVERSE TABLE TO DEGREES

9° — 0h 36m

Dist.	D.Lat	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	1·0	0·2	61	60·2	9·5	121	119·5	18·9	181	178·8	28·3	241	238·0	37·7
2	2·0	0·3	62	61·2	9·7	122	120·5	19·1	182	179·8	28·5	242	239·0	37·9
3	3·0	0·5	63	62·2	9·9	123	121·5	19·2	183	180·7	28·6	243	240·0	38·0
4	4·0	0·6	64	63·2	10·0	124	122·5	19·4	184	181·7	28·8	244	241·0	38·2
5	4·9	0·8	65	64·2	10·2	125	123·5	19·6	185	182·7	28·9	245	242·0	38·3
6	5·9	0·9	66	65·2	10·3	126	124·4	19·7	186	183·7	29·1	246	243·0	38·5
7	6·9	1·1	67	66·2	10·5	127	125·4	19·9	187	184·7	29·3	247	244·0	38·6
8	7·9	1·3	68	67·2	10·6	128	126·4	20·0	188	185·7	29·4	248	244·9	38·8
9	8·9	1·4	69	68·2	10·8	129	127·4	20·2	189	186·7	29·6	249	245·9	39·0
10	9·9	1·6	70	69·1	11·0	130	128·4	20·3	190	187·7	29·7	250	246·9	39·1
11	10·9	1·7	71	70·1	11·1	131	129·4	20·5	191	188·6	29·9	251	247·9	39·3
12	11·9	1·9	72	71·1	11·3	132	130·4	20·6	192	189·6	30·0	252	248·9	39·4
13	12·8	2·0	73	72·1	11·4	133	131·4	20·8	193	190·6	30·2	253	249·9	39·6
14	13·8	2·2	74	73·1	11·6	134	132·4	21·0	194	191·6	30·3	254	250·9	39·7
15	14·8	2·3	75	74·1	11·7	135	133·3	21·1	195	192·6	30·5	255	251·9	39·9
16	15·8	2·5	76	75·1	11·9	136	134·3	21·3	196	193 6	30·7	256	252·8	40·0
17	16·8	2·7	77	76·1	12·0	137	135·3	21·4	197	194·6	30·8	257	253·8	40·2
18	17·8	2·8	78	77·0	12·2	138	136·3	21·6	198	195·6	31·0	258	254·8	40·4
19	18·8	3·0	79	78·0	12·4	139	137·3	21·7	199	196·5	31·1	259	255·8	40·5
20	19·8	3·1	80	79·0	12·5	140	138·3	21·9	200	197·5	31·3	260	256·8	40·7
21	20·7	3·3	81	80·0	12·7	141	139·3	22·1	201	198·5	31·4	261	257·8	40·8
22	21·7	3·4	82	81·0	12·8	142	140·3	22·2	202	199·5	31·6	262	258·8	41·0
23	22·7	3·6	83	82·0	13·0	143	141·2	22·4	203	200·5	31·8	263	259·8	41·1
24	23·7	3·8	84	83·0	13·1	144	142·2	22·5	204	201·5	31·9	264	260·7	41·3
25	24·7	3·9	85	84·0	13·3	145	143·2	22·7	205	202·5	32·1	265	261·7	41·5
26	25·7	4·1	86	84·9	13·5	146	144·2	22·8	206	203·5	32·2	266	262·7	41·6
27	26·7	4·2	87	85·9	13·6	147	145·2	23·0	207	204·5	32·4	267	263·7	41·8
28	27·7	4·4	88	86·9	13·8	148	146·2	23·2	208	205·4	32·5	268	264·7	41·9
29	28·6	4·5	89	87·9	13·9	149	147·2	23·3	209	206·4	32·7	269	265·7	42·1
30	29·6	4·7	90	88·9	14·1	150	148·2	23·5	210	207·4	32·9	270	266·7	42·2
31	30·6	4·8	91	89·9	14·2	151	149·1	23·6	211	208·4	33·0	271	267·7	42·4
32	31·6	5·0	92	90·9	14·4	152	150·1	23·8	212	209·4	33·2	272	268·7	42·6
33	32·6	5·2	93	91·9	14·5	153	151·1	23·9	213	210·4	33·3	273	269·6	42·7
34	33·6	5·3	94	92·8	14·7	154	152·1	24·1	214	211·4	33·5	274	270·6	42·9
35	34·6	5·5	95	93·8	14·9	155	153·1	24·2	215	212·4	33·6	275	271·6	43·0
36	35·6	5·6	96	94·8	15·0	156	154·1	24·4	216	213·3	33·8	276	272·6	43·2
37	36·5	5·8	97	95·8	15·2	157	155·1	24·6	217	214·3	33·9	277	273·6	43·3
38	37·5	5·9	98	96·8	15·3	158	156·1	24·7	218	215·3	34·1	278	274·6	43·5
39	38·5	6·1	99	97·8	15·5	159	157·0	24·9	219	216·3	34·3	279	275·6	43·6
40	39·5	6·3	100	98·8	15·6	160	158·0	25·0	220	217·3	34·4	280	276·6	43·8
41	40·5	6·4	101	99·8	15·8	161	159·0	25·2	221	218·3	34·6	281	277·5	44·0
42	41·5	6·6	102	100·7	16 0	162	160·0	25·3	222	219·3	34·7	282	278·5	44·1
43	42·5	6·7	103	101·7	16·1	163	161·0	25·5	223	220·3	34·9	283	279·5	44·3
44	43·5	6·9	104	102·7	16·3	164	162·0	25·7	224	221·2	35·0	284	280·5	44·4
45	44·4	7·0	105	103·7	16·4	165	163·0	25·8	225	222·2	35·2	285	281·5	44·6
46	45·4	7·2	106	104·7	16·6	166	164·0	26·0	226	223·2	35·4	286	282·5	44·7
47	46·4	7·4	107	105·7	16·7	167	164·9	26·1	227	224·2	35·5	287	283·5	44·9
48	47·4	7·5	108	106·7	16·9	168	165·9	26·3	228	225·2	35·7	288	284·5	45·1
49	48·4	7·7	109	107·7	17·1	169	166·9	26·4	229	226·2	35·8	289	285·4	45·2
50	49·4	7·8	110	108·6	17·2	170	167·9	26·6	230	227·2	36·0	290	286·4	45·4
51	50·4	8·0	111	109·6	17·4	171	168·9	26·8	231	228·2	36·1	291	287·4	45·5
52	51·4	8·1	112	110·6	17·5	172	169·9	26·9	232	229·1	36·3	292	288·4	45·7
53	52·3	8·3	113	111·6	17·7	173	170·9	27·1	233	230·1	36·4	293	289·4	45·8
54	53·3	8·4	114	112·6	17·8	174	171·9	27·2	234	231·1	36·6	294	290·4	46·0
55	54·3	8·6	115	113·6	18·0	175	172·8	27·4	235	232·1	36·8	295	291·4	46·1
56	55·3	8·8	116	114·6	18·1	176	173·8	27·5	236	233·1	36·9	296	292·4	46·3
57	56·3	8·9	117	115·6	18·3	177	174·8	27·7	237	234·1	37·1	297	293·3	46·5
58	57·3	9·1	118	116·5	18·5	178	175·8	27·8	238	235·1	37·2	298	294·3	46·6
59	58·3	9·2	119	117·5	18·6	179	176·8	28·0	239	236·1	37·4	299	295·3	46·8
60	59·3	9·4	120	118·5	18·8	180	177·8	28·2	240	237·0	37·5	300	296·3	46·9
Dist.	Dep.	D.Lat	Dist.	Dep.	D.Lat	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat.

81° — 5h 24m

TRAVERSE TABLE TO DEGREES

9° 0h 36m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	297·3	47·1	361	356·6	56·5	421	415·8	65·9	481	475·1	75·2	541	534·4	84·6
302	298·3	47·2	362	357·5	56·7	422	416·8	66·0	482	476·1	75·3	542	535·4	84·7
303	299·3	47·4	363	358·5	56·8	423	417·8	66·2	483	477·1	75·5	543	536·3	84·9
304	300·3	47·6	364	359·5	56·9	424	418·8	66·3	484	478·0	75·6	544	537·3	85·1
305	301·2	47·7	365	360·5	57·1	425	419·8	66·5	485	479·0	75·8	545	538·3	85·3
306	302·2	47·9	366	361·5	57·3	426	420·8	66·6	486	480·0	75·9	546	539·3	85·4
307	303·2	48·0	367	362·5	57·4	427	421·7	66·8	487	481·0	76·1	547	540·3	85·6
308	304·2	48·2	368	363·5	57·6	428	422·7	67·0	488	482·0	76·2	548	541·3	85·7
309	305·2	48·3	369	364·5	57·7	429	423·7	67·1	489	483·0	76·4	549	542·3	85·9
310	306·2	48·5	370	365·4	57·9	430	424·7	67·3	490	484·0	76·5	550	543·3	86·0
311	307·2	48·7	371	366·4	58·1	431	425·7	67·4	491	485·0	76·7	551	544·3	86·2
312	308·2	48·8	372	367·4	58·2	432	426·7	67·6	492	485·9	76·8	552	545·2	86·3
313	309·1	49·0	373	368·4	58·4	433	427·7	67·7	493	486·9	77·0	553	546·2	86·5
314	310·1	49·1	374	369·4	58·5	434	428·7	67·9	494	487·9	77·1	554	547·2	86·6
315	311·1	49·3	375	370·4	58·7	435	429·6	68·1	495	488·9	77·3	555	548·2	86·8
316	312·1	49·4	376	371·4	58·8	436	430·6	68·2	496	489·9	77·5	556	549·2	87·0
317	313·1	49·6	377	372·4	59·0	437	431·6	68·4	497	490·9	77·7	557	550·2	87·1
318	314·1	49·8	378	373·3	59·1	438	432·6	68·5	498	491·9	77·9	558	551·2	87·3
319	315·1	49·9	379	374·3	59·3	439	433·6	68·7	499	492·9	78·0	559	552·2	87·4
320	316·1	50·1	380	375·3	59·5	440	434·6	68·8	500	493·8	78·2	560	553·1	87·6
321	317·0	50·2	381	376·3	59·6	441	435·6	69·0	501	494·8	78·4	561	554·1	87·7
322	318·0	50·4	382	377·3	59·8	442	436·6	69·1	502	495·8	78·5	562	555·1	87·9
323	319·0	50·5	383	378·3	59·9	443	437·5	69·3	503	496·8	78·7	563	556·1	88·0
324	320·0	50·7	384	379·3	60·1	444	438·5	69·5	504	497·8	78·8	564	557·1	88·2
325	321·0	50·8	385	380·3	60·2	445	439·5	69·6	505	498·8	79·0	565	558·1	88·3
326	322·0	51·0	386	381·2	60·4	446	440·5	69·8	506	499·8	79·1	566	559·1	88·5
327	323·0	51·2	387	382·2	60·5	447	441·5	69·9	507	500·8	79·2	567	560·1	88·6
328	324·0	51·3	388	383·2	60·7	448	442·5	70·1	508	501·7	79·4	568	561·0	88·8
329	324·9	51·5	389	384·2	60·9	449	443·5	70·2	509	502·7	79·5	569	562·0	88·9
330	325·9	51·7	390	385·2	61·0	450	444·5	70·4	510	503·7	79·7	570	563·0	89·1
331	326·9	51·8	391	386·2	61·2	451	445·4	70·6	511	504·7	79·8	571	564·0	89·2
332	327·9	51·9	392	387·2	61·3	452	446·4	70·7	512	505·7	80·1	572	565·0	89·4
333	328·9	52·1	393	388·2	61·5	453	447·4	70·9	513	506·7	80·2	573	566·0	89·5
334	329·9	52·3	394	389·1	61·6	454	448·4	71·0	514	507·7	80·3	574	567·0	89·7
335	330·9	52·4	395	390·1	61·8	455	449·4	71·2	515	508·7	80·5	575	568·0	89·9
336	331·9	52·6	396	391·1	62·0	456	450·4	71·3	516	509·6	80·6	576	568·9	90·1
337	332·8	52·7	397	392·1	62·1	457	451·4	71·5	517	510·6	80·8	577	569·9	90·2
338	333·8	52·9	398	393·1	62·3	458	452·4	71·7	518	511·6	80·9	578	570·9	90·3
339	334·8	53·0	399	394·1	62·4	459	453·3	71·8	519	512·6	81·1	579	571·9	90·5
340	335·8	53·2	400	395·1	62·6	460	454·3	72·0	520	513·6	81·3	580	572·9	90·7
341	336·8	53·3	401	396·1	62·7	461	455·3	72·1	521	514·6	81·4	581	573·9	90·9
342	337·8	53·5	402	397·0	62·9	462	456·3	72·3	522	515·6	81·6	582	574·9	91·0
343	338·8	53·7	403	398·0	63·0	463	457·3	72·4	523	516·6	81·8	583	575·9	91·2
344	339·8	53·8	404	399·0	63·2	464	458·3	72·6	524	517·6	81·9	584	576·9	91·3
345	340·8	54·0	405	400·0	63·4	465	459·3	72·7	525	518·6	82·1	585	577·9	91·5
346	341·7	54·1	406	401·0	63·5	466	460·3	72·9	526	519·5	82·3	586	578·8	91·7
347	342·7	54·3	407	402·0	63·7	467	461·2	73·1	527	520·5	82·4	587	579·8	91·8
348	343·7	54·4	408	403·0	63·8	468	462·2	73·2	528	521·5	82·6	588	580·8	92·0
349	344·7	54·6	409	404·0	64·0	469	463·2	73·4	529	522·5	82·7	589	581·8	92·1
350	345·7	54·8	410	405·0	64·1	470	464·2	73·5	530	523·5	82·9	590	582·8	92·2
351	346·7	54·9	411	405·9	64·3	471	465·2	73·7	531	524·5	83·1	591	583·8	92·4
352	347·7	55·1	412	406·9	64·5	472	466·2	73·8	532	525·5	83·2	592	584·8	92·5
353	348·7	55·2	413	407·9	64·6	473	467·2	74·0	533	526·5	83·4	593	585·7	92·7
354	349·6	55·4	414	408·9	64·8	474	468·2	74·2	534	527·5	83·5	594	586·7	92·9
355	350·6	55·5	415	409·9	64·9	475	469·2	74·3	535	528·4	83·7	595	587·7	93·1
356	351·6	55·7	416	410·9	65·1	476	470·1	74·5	536	529·4	83·8	596	588·7	93·2
357	352·6	55·9	417	411·9	65·2	477	471·1	74·6	537	530·4	84·0	597	589·7	93·4
358	353·6	56·0	418	412·9	65·4	478	472·1	74·8	538	531·4	84·1	598	590·7	93·5
359	354·6	56·2	419	413·8	65·6	479	473·1	74·9	539	532·4	84·3	599	591·7	93·7
360	355·6	56·3	420	414·8	65·7	480	474·1	75·0	540	533·4	84·4	600	592·6	93·8
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

81° 5h 24m

TRAVERSE TABLE TO DEGREES

10° **0h 40m**

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	1.0	0.2	61	60.1	10.6	121	119.2	21.0	181	178.3	31.4	241	237.3	41.8
2	2.0	0.3	62	61.1	10.8	122	120.1	21.2	182	179.2	31.6	242	238.3	42.0
3	3.0	0.5	63	62.0	10.9	123	121.1	21.4	183	180.2	31.8	243	239.3	42.2
4	3.9	0.7	64	63.0	11.1	124	122.1	21.5	184	181.2	32.0	244	240.3	42.4
5	4.9	0.9	65	64.0	11.3	125	123.1	21.7	185	182.2	32.1	245	241.3	42.5
6	5.9	1.0	66	65.0	11.5	126	124.1	21.9	186	183.2	32.3	246	242.3	42.7
7	6.9	1.2	67	66.0	11.6	127	125.1	22.1	187	184.2	32.5	247	243.2	42.9
8	7.9	1.4	68	67.0	11.8	128	126.1	22.2	188	185.1	32.6	248	244.2	43.1
9	8.9	1.6	69	68.0	12.0	129	127.0	22.4	189	186.1	32.8	249	245.2	43.2
10	9.8	1.7	70	68.9	12.2	130	128.0	22.6	190	187.1	33.0	250	246.2	43.4
11	10.8	1.9	71	69.9	12.3	131	129.0	22.7	191	188.1	33.2	251	247.2	43.6
12	11.8	2.1	72	70.9	12.5	132	130.0	22.9	192	189.1	33.3	252	248.2	43.8
13	12.8	2.3	73	71.9	12.7	133	131.0	23.1	193	190.1	33.5	253	249.2	43.9
14	13.8	2.4	74	72.9	12.8	134	132.0	23.3	194	191.1	33.7	254	250.1	44.1
15	14.8	2.6	75	73.9	13.0	135	132.9	23.4	195	192.0	33.9	255	251.1	44.3
16	15.8	2.8	76	74.8	13.2	136	133.9	23.6	196	193.0	34.0	256	252.1	44.5
17	16.7	3.0	77	75.8	13.4	137	134.9	23.8	197	194.0	34.2	257	253.1	44.6
18	17.7	3.1	78	76.8	13.5	138	135.9	24.0	198	195.0	34.4	258	254.1	44.8
19	18.7	3.3	79	77.8	13.7	139	136.9	24.1	199	196.0	34.6	259	255.1	45.0
20	19.7	3.5	80	78.8	13.9	140	137.9	24.3	200	197.0	34.7	260	256.1	45.1
21	20.7	3.6	81	79.8	14.1	141	138.9	24.5	201	197.9	34.9	261	257.0	45.3
22	21.7	3.8	82	80.8	14.2	142	139.8	24.7	202	198.9	35.1	262	258.0	45.5
23	22.7	4.0	83	81.7	14.4	143	140.8	24.8	203	199.9	35.3	263	259.0	45.7
24	23.6	4.2	84	82.7	14.6	144	141.8	25.0	204	200.9	35.4	264	260.0	45.8
25	24.6	4.3	85	83.7	14.8	145	142.8	25.2	205	201.9	35.6	265	261.0	46.0
26	25.6	4.5	86	84.7	14.9	146	143.8	25.4	206	202.9	35.8	266	262.0	46.2
27	26.6	4.7	87	85.7	15.1	147	144.8	25.5	207	203.9	35.9	267	262.9	46.4
28	27.6	4.9	88	86.7	15.3	148	145.8	25.7	208	204.8	36.1	268	263.9	46.5
29	28.6	5.0	89	87.6	15.5	149	146.7	25.9	209	205.8	36.3	269	264.9	46.7
30	29.5	5.2	90	88.6	15.6	150	147.7	26.0	210	206.8	36.5	270	265.9	46.9
31	30.5	5.4	91	89.6	15.8	151	148.7	26.2	211	207.8	36.6	271	266.9	47.1
32	31.5	5.6	92	90.6	16.0	152	149.7	26.4	212	208.8	36.8	272	267.9	47.2
33	32.5	5.7	93	91.6	16.1	153	150.7	26.6	213	209.8	37.0	273	268.9	47.4
34	33.5	5.9	94	92.6	16.3	154	151.7	26.7	214	210.7	37.2	274	269.8	47.6
35	34.5	6.1	95	93.6	16.5	155	152.6	26.9	215	211.7	37.3	275	270.8	47.8
36	35.5	6.3	96	94.5	16.7	156	153.6	27.1	216	212.7	37.5	276	271.8	47.9
37	36.4	6.4	97	95.5	16.8	157	154.6	27.3	217	213.7	37.7	277	272.8	48.1
38	37.4	6.6	98	96.5	17.0	158	155.6	27.4	218	214.7	37.9	278	273.8	48.3
39	38.4	6.8	99	97.5	17.2	159	156.6	27.6	219	215.7	38.0	279	274.8	48.4
40	39.4	6.9	100	98.5	17.4	160	157.6	27.8	220	216.7	38.2	280	275.7	48.6
41	40.4	7.1	101	99.5	17.5	161	158.6	28.0	221	217.6	38.4	281	276.7	48.8
42	41.4	7.3	102	100.5	17.7	162	159.5	28.1	222	218.6	38.5	282	277.7	49.0
43	42.3	7.5	103	101.4	17.9	163	160.5	28.3	223	219.6	38.7	283	278.7	49.1
44	43.3	7.6	104	102.4	18.1	164	161.5	28.5	224	220.6	38.9	284	279.7	49.3
45	44.3	7.8	105	103.4	18.2	165	162.5	28.7	225	221.6	39.1	285	280.7	49.5
46	45.3	8.0	106	104.4	18.4	166	163.5	28.8	226	222.6	39.2	286	281.7	49.7
47	46.3	8.2	107	105.4	18.6	167	164.5	29.0	227	223.6	39.4	287	282.6	49.8
48	47.3	8.3	108	106.4	18.8	168	165.4	29.2	228	224.5	39.6	288	283.6	50.0
49	48.3	8.5	109	107.3	18.9	169	166.4	29.3	229	225.5	39.8	289	284.6	50.2
50	49.2	8.7	110	108.3	19.1	170	167.4	29.5	230	226.5	39.9	290	285.6	50.4
51	50.2	8.9	111	109.3	19.3	171	168.4	29.7	231	227.5	40.1	291	286.6	50.5
52	51.2	9.0	112	110.3	19.4	172	169.4	29.9	232	228.5	40.3	292	287.6	50.7
53	52.2	9.2	113	111.3	19.6	173	170.4	30.0	233	229.5	40.5	293	288.5	50.9
54	53.2	9.4	114	112.3	19.8	174	171.4	30.2	234	230.4	40.6	294	289.5	51.1
55	54.2	9.6	115	113.3	20.0	175	172.3	30.4	235	231.4	40.8	295	290.5	51.2
56	55.1	9.7	116	114.2	20.1	176	173.3	30.6	236	232.4	41.0	296	291.5	51.4
57	56.1	9.9	117	115.2	20.3	177	174.3	30.7	237	233.4	41.2	297	292.5	51.6
58	57.1	10.1	118	116.2	20.5	178	175.3	30.9	238	234.4	41.3	298	293.5	51.7
59	58.1	10.2	119	117.2	20.7	179	176.3	31.1	239	235.4	41.5	299	294.5	51.9
60	59.1	10.4	120	118.2	20.8	180	177.3	31.3	240	236.4	41.7	300	295.4	52.1
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

80° **5h 20m**

TRAVERSE TABLE TO DEGREES

10° — $0^h\ 40^m$

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	296·4	52·3	361	355·5	62·7	421	414·6	73·1	481	473·7	83·5	541	532·8	93·9
302	297·4	52·5	362	356·5	62·9	422	415·6	73·3	482	474·7	83·7	542	533·8	94·1
303	298·4	52·6	363	357·5	63·0	423	416·6	73·5	483	475·7	83·9	543	534·8	94·3
304	299·4	52·8	364	358·5	63·2	424	417·6	73·6	484	476·6	84·1	544	535·7	94·5
305	300·4	53·0	365	359·5	63·4	425	418·5	73·8	485	477·6	84·2	545	536·7	94·6
306	301·4	53·1	366	360·4	63·6	426	419·5	74·0	486	478·6	84·4	546	537·7	94·8
307	302·3	53·3	367	361·4	63·7	427	420·5	74·2	487	479·6	84·6	547	538·7	95·0
308	303·3	53·5	368	362·4	63·9	428	421·5	74·3	488	480·6	84·7	548	539·7	95·1
309	304·3	53·7	369	363·4	64·1	429	422·5	74·5	489	481·6	84·9	549	540·7	95·3
310	305·3	53·8	370	364·4	64·3	430	423·5	74·7	490	482·6	85·1	550	541·6	95·5
311	306·3	54·0	371	365·4	64·4	431	424·5	74·9	491	483·5	85·2	551	542·6	95·6
312	307·3	54·2	372	366·4	64·6	432	425·4	75·0	492	484·5	85·4	552	543·6	95·8
313	308·2	54·3	373	367·3	64·8	433	426·4	75·2	493	485·5	85·6	553	544·6	96·0
314	309·2	54·5	374	368·3	65·0	434	427·4	75·4	494	486·5	85·8	554	545·6	96·2
315	310·2	54·7	375	369·3	65·1	435	428·4	75·5	495	487·5	85·9	555	546·6	96·3
316	311·2	54·9	376	370·3	65·3	436	429·4	75·7	496	488·5	86·1	556	547·5	96·5
317	312·2	55·1	377	371·3	65·5	437	430·4	75·9	497	489·4	86·3	557	548·5	96·7
318	313·2	55·2	378	372·3	65·6	438	431·3	76·1	498	490·4	86·5	558	549·5	96·9
319	314·2	55·4	379	373·2	65·8	439	432·3	76·2	499	491·4	86·6	559	550·5	97·0
320	315·1	55·6	380	374·2	66·0	440	433·3	76·4	500	492·4	86·8	560	551·5	97·2
321	316·1	55·8	381	375·2	66·2	441	434·3	76·6	501	493·4	87·0	561	552·5	97·4
322	317·1	55·9	382	376·2	66·3	442	435·3	76·8	502	494·4	87·2	562	553·5	97·6
323	318·1	56·1	383	377·2	66·5	443	436·3	76·9	503	495·3	87·3	563	554·4	97·7
324	319·1	56·3	384	378·2	66·7	444	437·3	77·1	504	496·3	87·5	564	555·4	97·9
325	320·1	56·4	385	379·2	66·9	445	438·2	77·3	505	497·3	87·7	565	556·4	98·1
326	321·0	56·6	386	380·1	67·0	446	439·2	77·5	506	498·3	87·9	566	557·4	98·3
327	322·0	56·8	387	381·1	67·2	447	440·2	77·6	507	499·3	88·0	567	558·4	98·4
328	323·0	57·0	388	382·1	67·4	448	441·2	77·8	508	500·3	88·2	568	559·4	98·6
329	324·0	57·1	389	383·1	67·6	449	442·2	78·0	509	501·3	88·4	569	560·3	98·8
330	325·0	57·3	390	384·1	67·7	450	443·2	78·2	510	502·2	88·6	570	561·3	99·0
331	326·0	57·5	391	385·1	67·9	451	444·2	78·3	511	503·2	88·7	571	562·3	99·1
332	327·0	57·7	392	386·0	68·1	452	445·1	78·5	512	504·2	88·9	572	563·3	99·3
333	327·9	57·8	393	387·0	68·2	453	446·1	78·7	513	505·2	89·1	573	564·3	99·5
334	328·9	58·0	394	388·0	68·4	454	447·1	78·8	514	506·2	89·2	574	565·3	99·6
335	329·9	58·2	395	389·0	68·6	455	448·1	79·0	515	507·2	89·4	575	566·3	99·8
336	330·9	58·4	396	390·0	68·8	456	449·1	79·2	516	508·2	89·6	576	567·2	100·0
337	331·9	58·5	397	391·0	68·9	457	450·1	79·4	517	509·1	89·8	577	568·2	100·2
338	332·9	58·7	398	392·0	69·1	458	451·0	79·5	518	510·1	89·9	578	569·2	100·3
339	333·9	58·9	399	392·9	69·3	459	452·0	79·7	519	511·1	90·1	579	570·2	100·5
340	334·8	59·1	400	393·9	69·5	460	453·0	79·9	520	512·1	90·3	580	571·2	100·7
341	335·8	59·2	401	394·9	69·6	461	454·0	80·1	521	513·1	90·5	581	572·2	100·9
342	336·8	59·4	402	395·9	69·8	462	455·0	80·2	522	514·1	90·6	582	573·2	101·0
343	337·8	59·6	403	396·9	70·0	463	456·0	80·4	523	515·1	90·8	583	574·1	101·2
344	338·8	59·8	404	397·9	70·2	464	457·0	80·6	524	516·0	91·0	584	575·1	101·4
345	339·8	59·9	405	398·9	70·3	465	457·9	80·8	525	517·0	91·2	585	576·1	101·6
346	340·7	60·1	406	399·8	70·5	466	458·9	80·9	526	518·0	91·3	586	577·1	101·7
347	341·7	60·3	407	400·8	70·7	467	459·9	81·1	527	519·0	91·5	587	578·1	101·9
348	342·7	60·4	408	401·8	70·9	468	460·9	81·3	528	520·0	91·7	588	579·1	102·1
349	343·7	60·6	409	402·8	71·0	469	461·9	81·5	529	521·0	91·9	589	580·0	102·3
350	344·7	60·8	410	403·8	71·2	470	462·9	81·6	530	521·9	92·0	590	581·0	102·4
351	345·7	61·0	411	404·8	71·4	471	463·8	81·8	531	522·9	92·2	591	582·0	102·6
352	346·7	61·1	412	405·7	71·6	472	464·8	82·0	532	523·9	92·4	592	583·0	102·8
353	347·6	61·3	413	406·7	71·7	473	465·8	82·1	533	524·9	92·5	593	584·0	102·9
354	348·6	61·5	414	407·7	71·9	474	466·8	82·3	534	525·9	92·7	594	585·0	103·1
355	349·6	61·7	415	408·7	72·1	475	467·8	82·5	535	526·9	92·9	595	586·0	103·3
356	350·6	61·8	416	409·7	72·2	476	468·8	82·7	536	527·9	93·1	596	586·9	103·5
357	351·6	62·0	417	410·7	72·4	477	469·8	82·8	537	528·8	93·2	597	587·9	103·6
358	352·6	62·2	418	411·7	72·6	478	470·7	83·0	538	529·8	93·4	598	588·9	103·8
359	353·5	62·4	419	412·6	72·8	479	471·7	83·2	539	530·8	93·6	599	589·9	104·0
360	354·5	62·5	420	413·6	72·9	480	472·7	83·4	540	531·8	93·8	600	590·9	104·2
Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

80° — $5^h\ 20^m$

TRAVERSE TABLE TO DEGREES

11° — 0h 44m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	1.0	0.2	61	59.9	11.6	121	118.8	23.1	181	177.7	34.5	241	236.6	46.0
2	2.0	0.4	62	60.9	11.8	122	119.8	23.3	182	178.7	34.7	242	237.6	46.2
3	2.9	0.6	63	61.8	12.0	123	120.7	23.5	183	179.6	34.9	243	238.5	46.4
4	3.9	0.8	64	62.8	12.2	124	121.7	23.7	184	180.6	35.1	244	239.5	46.6
5	4.9	1.0	65	63.8	12.4	125	122.7	23.9	185	181.6	35.3	245	240.5	46.7
6	5.9	1.1	66	64.8	12.6	126	123.7	24.0	186	182.6	35.5	246	241.5	46.9
7	6.9	1.3	67	65.8	12.8	127	124.7	24.2	187	183.6	35.7	247	242.5	47.1
8	7.9	1.5	68	66.8	13.0	128	125.6	24.4	188	184.5	35.9	248	243.4	47.3
9	8.8	1.7	69	67.7	13.2	129	126.6	24.6	189	185.5	36.1	249	244.4	47.5
10	9.8	1.9	70	68.7	13.4	130	127.6	24.8	190	186.5	36.3	250	245.4	47.7
11	10.8	2.1	71	69.7	13.5	131	128.6	25.0	191	187.5	36.4	251	246.4	47.9
12	11.8	2.3	72	70.7	13.7	132	129.6	25.2	192	188.5	36.6	252	247.4	48.1
13	12.8	2.5	73	71.7	13.9	133	130.6	25.4	193	189.5	36.8	253	248.4	48.3
14	13.7	2.7	74	72.6	14.1	134	131.5	25.6	194	190.4	37.0	254	249.3	48.5
15	14.7	2.9	75	73.6	14.3	135	132.5	25.8	195	191.4	37.2	255	250.3	48.7
16	15.7	3.1	76	74.6	14.5	136	133.5	26.0	196	192.4	37.4	256	251.3	48.8
17	16.7	3.2	77	75.6	14.7	137	134.5	26.1	197	193.4	37.6	257	252.3	49.0
18	17.7	3.4	78	76.6	14.9	138	135.5	26.3	198	194.4	37.8	258	253.3	49.2
19	18.7	3.6	79	77.5	15.1	139	136.4	26.5	199	195.3	38.0	259	254.2	49.4
20	19.6	3.8	80	78.5	15.3	140	137.4	26.7	200	196.3	38.2	260	255.2	49.6
21	20.6	4.0	81	79.5	15.5	141	138.4	26.9	201	197.3	38.4	261	256.2	49.8
22	21.6	4.2	82	80.5	15.6	142	139.4	27.1	202	198.3	38.5	262	257.2	50.0
23	22.6	4.4	83	81.5	15.8	143	140.4	27.3	203	199.3	38.7	263	258.2	50.2
24	23.6	4.6	84	82.5	16.0	144	141.4	27.5	204	200.3	38.9	264	259.1	50.4
25	24.5	4.8	85	83.4	16.2	145	142.3	27.7	205	201.2	39.1	265	260.1	50.6
26	25.5	5.0	86	84.4	16.4	146	143.3	27.9	206	202.2	39.3	266	261.1	50.8
27	26.5	5.2	87	85.4	16.6	147	144.3	28.0	207	203.2	39.5	267	262.1	50.9
28	27.5	5.3	88	86.4	16.8	148	145.3	28.2	208	204.2	39.7	268	263.1	51.1
29	28.5	5.5	89	87.4	17.0	149	146.3	28.4	209	205.2	39.9	269	264.1	51.3
30	29.4	5.7	90	88.3	17.2	150	147.2	28.6	210	206.1	40.1	270	265.0	51.5
31	30.4	5.9	91	89.3	17.4	151	148.2	28.8	211	207.1	40.3	271	266.0	51.7
32	31.4	6.1	92	90.3	17.6	152	149.2	29.0	212	208.1	40.5	272	267.0	51.9
33	32.4	6.3	93	91.3	17.7	153	150.2	29.2	213	209.1	40.6	273	268.0	52.1
34	33.4	6.5	94	92.3	17.9	154	151.2	29.4	214	210.1	40.8	274	269.0	52.3
35	34.4	6.7	95	93.3	18.1	155	152.2	29.6	215	211.0	41.0	275	269.9	52.5
36	35.3	6.9	96	94.2	18.3	156	153.1	29.8	216	212.0	41.2	276	270.9	52.7
37	36.3	7.1	97	95.2	18.5	157	154.1	30.0	217	213.0	41.4	277	271.9	52.9
38	37.3	7.3	98	96.2	18.7	158	155.1	30.1	218	214.0	41.6	278	272.9	53.0
39	38.3	7.4	99	97.2	18.9	159	156.1	30.3	219	215.0	41.8	279	273.9	53.2
40	39.3	7.6	100	98.2	19.1	160	157.1	30.5	220	216.0	42.0	280	274.9	53.4
41	40.2	7.8	101	99.1	19.3	161	158.0	30.7	221	216.9	42.2	281	275.8	53.6
42	41.2	8.0	102	100.1	19.5	162	159.0	30.9	222	217.9	42.4	282	276.8	53.8
43	42.2	8.2	103	101.1	19.7	163	160.0	31.1	223	218.9	42.6	283	277.8	54.0
44	43.2	8.4	104	102.1	19.8	164	161.0	31.3	224	219.9	42.7	284	278.8	54.2
45	44.2	8.6	105	103.1	20.0	165	162.0	31.5	225	220.9	42.9	285	279.8	54.4
46	45.2	8.8	106	104.1	20.2	166	163.0	31.7	226	221.8	43.1	286	280.7	54.6
47	46.1	9.0	107	105.0	20.4	167	163.9	31.9	227	222.8	43.3	287	281.7	54.8
48	47.1	9.2	108	106.0	20.6	168	164.9	32.1	228	223.8	43.5	288	282.7	55.0
49	48.1	9.3	109	107.0	20.8	169	165.9	32.2	229	224.8	43.7	289	283.7	55.1
50	49.1	9.5	110	108.0	21.0	170	166.9	32.4	230	225.8	43.9	290	284.7	55.3
51	50.1	9.7	111	109.0	21.2	171	167.9	32.6	231	226.8	44.1	291	285.7	55.5
52	51.0	9.9	112	109.9	21.4	172	168.8	32.8	232	227.7	44.3	292	286.6	55.7
53	52.0	10.1	113	110.9	21.6	173	169.8	33.0	233	228.7	44.5	293	287.6	55.9
54	53.0	10.3	114	111.9	21.8	174	170.8	33.2	234	229.7	44.6	294	288.6	56.1
55	54.0	10.5	115	112.9	21.9	175	171.8	33.4	235	230.7	44.8	295	289.6	56.3
56	55.0	10.7	116	113.9	22.1	176	172.8	33.6	236	231.7	45.0	296	290.6	56.5
57	56.0	10.9	117	114.9	22.3	177	173.7	33.8	237	232.6	45.2	297	291.5	56.7
58	56.9	11.1	118	115.8	22.5	178	174.7	34.0	238	233.6	45.4	298	292.5	56.9
59	57.9	11.3	119	116.8	22.7	179	175.7	34.2	239	234.6	45.6	299	293.5	57.1
60	58.9	11.4	120	117.8	22.9	180	176.7	34.3	240	235.6	45.8	300	294.5	57.2
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

79° — 5h 16m

TRAVERSE TABLE TO DEGREES

11° 0h 44m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	295·4	57·4	361	354·3	68·9	421	413·2	80·3	481	472·1	91·8	541	531·0	103·2
302	296·4	57·6	362	355·3	69·1	422	414·2	80·5	482	473·1	92·0	542	532·0	103·4
303	297·4	57·8	363	356·3	69·3	423	415·2	80·7	483	474·1	92·2	543	533·0	103·6
304	298·4	58·0	364	357·3	69·5	424	416·2	80·9	484	475·1	92·4	544	534·0	103·8
305	299·4	58·2	365	358·3	69·6	425	417·2	81·1	485	476·1	92·6	545	535·0	104·0
306	300·3	58·4	366	359·2	69·8	426	418·1	81·3	486	477·0	92·8	546	535·9	104·2
307	301·3	58·6	367	360·2	70·0	427	419·1	81·5	487	478·0	93·0	547	536·9	104·4
308	302·3	58·8	368	361·2	70·2	428	420·1	81·7	488	479·0	93·2	548	537·9	104·6
309	303·3	59·0	369	362·2	70·4	429	421·1	81·9	489	480·0	93·3	549	538·9	104·8
310	304·3	59·2	370	363·2	70·6	430	422·1	82·1	490	481·0	93·5	550	539·9	105·0
311	305·3	59·3	371	364·1	70·8	431	423·0	82·2	491	481·9	93·6	551	540·8	105·1
312	306·2	59·5	372	365·1	71·0	432	424·0	82·4	492	482·9	93·8	552	541·8	105·3
313	307·2	59·7	373	366·1	71·2	433	425·0	82·6	493	483·9	94·0	553	542·8	105·5
314	308·2	59·9	374	367·1	71·4	434	426·0	82·8	494	484·9	94·2	554	543·8	105·7
315	309·2	60·1	375	368·1	71·6	435	427·0	83·0	495	485·9	94·4	555	544·8	105·9
316	310·2	60·3	376	369·1	71·7	436	428·0	83·2	496	486·9	94·6	556	545·8	106·1
317	311·1	60·5	377	370·0	71·9	437	428·9	83·4	497	487·8	94·8	557	546·7	106·3
318	312·1	60·7	378	371·0	72·1	438	429·9	83·6	498	488·8	95·0	558	547·7	106·5
319	313·1	60·9	379	372·0	72·3	439	430·9	83·8	499	489·8	95·2	559	548·7	106·7
320	314·1	61·1	380	373·0	72·5	440	431·9	84·0	500	490·8	95·4	560	549·7	106·9
321	315·1	61·3	381	374·0	72·7	441	432·9	84·1	501	491·8	95·6	561	550·7	107·1
322	316·1	61·4	382	374·9	72·9	442	433·8	84·3	502	492·7	95·8	562	551·6	107·2
323	317·0	61·6	383	375·9	73·1	443	434·8	84·5	503	493·7	96·0	563	552·6	107·4
324	318·0	61·8	384	376·9	73·3	444	435·8	84·7	504	494·7	96·2	564	553·6	107·6
325	319·0	62·0	385	377·9	73·5	445	436·8	84·9	505	495·7	96·4	565	554·6	107·8
326	320·0	62·2	386	378·9	73·7	446	437·8	85·1	506	496·7	96·6	566	555·6	108·0
327	321·0	62·4	387	379·9	73·8	447	438·8	85·3	507	497·7	96·8	567	556·6	108·2
328	321·9	62·6	388	380·8	74·0	448	439·7	85·5	508	498·6	97·0	568	557·6	108·4
329	322·9	62·8	389	381·8	74·2	449	440·7	85·7	509	499·6	97·2	569	558·6	108·6
330	323·9	63·0	390	382·8	74·4	450	441·7	85·9	510	500·6	97·3	570	559·5	108·8
331	324·9	63·2	391	383·8	74·6	451	442·7	86·1	511	501·6	97·5	571	560·5	109·0
332	325·9	63·4	392	384·8	74·8	452	443·7	86·2	512	502·6	97·6	572	561·5	109·1
333	326·8	63·5	393	385·7	75·0	453	444·6	86·4	513	503·5	97·8	573	562·5	109·3
334	327·8	63·7	394	386·7	75·2	454	445·6	86·6	514	504·5	98·0	574	563·5	109·5
335	328·8	63·9	395	387·7	75·4	455	446·6	86·8	515	505·5	98·2	575	564·5	109·7
336	329·8	64·1	396	388·7	75·6	456	447·6	87·0	516	506·5	98·4	576	565·4	109·9
337	330·8	64·3	397	389·7	75·8	457	448·6	87·2	517	507·5	98·6	577	566·4	110·1
338	331·8	64·5	398	390·7	75·9	458	449·6	87·4	518	508·5	98·8	578	567·4	110·3
339	332·7	64·7	399	391·6	76·1	459	450·5	87·6	519	509·4	99·0	579	568·3	110·5
340	333·7	64·9	400	392·6	76·3	460	451·5	87·8	520	510·4	99·2	580	569·3	110·7
341	334·7	65·1	401	393·6	76·5	461	452·5	88·0	521	511·4	99·4	581	570·3	110·9
342	335·7	65·3	402	394·6	76·7	462	453·5	88·2	522	512·4	99·6	582	571·3	111·1
343	336·7	65·5	403	395·6	76·9	463	454·5	88·3	523	513·4	99·8	583	572·3	111·3
344	337·6	65·6	404	396·5	77·1	464	455·4	88·5	524	514·3	100·0	584	573·2	111·5
345	338·6	65·8	405	397·5	77·3	465	456·4	88·7	525	515·3	100·2	585	574·2	111·7
346	339·6	66·0	406	398·5	77·5	466	457·4	88·9	526	516·3	100·4	586	575·2	111·8
347	340·6	66·2	407	399·5	77·7	467	458·4	89·1	527	517·3	100·6	587	576·2	112·1
348	341·6	66·4	408	400·5	77·9	468	459·4	89·3	528	518·3	100·8	588	577·2	112·3
349	342·6	66·6	409	401·5	78·1	469	460·4	89·5	529	519·3	101·0	589	578·2	112·4
350	343·5	66·8	410	402·4	78·2	470	461·3	89·7	530	520·2	101·2	590	579·1	112·6
351	344·5	67·0	411	403·4	78·4	471	462·3	89·9	531	521·2	101·4	591	580·1	112·8
352	345·5	67·2	412	404·4	78·6	472	463·3	90·1	532	522·2	101·6	592	581·1	113·0
353	346·5	67·4	413	405·4	78·8	473	464·3	90·3	533	523·2	101·7	593	582·1	113·2
354	347·5	67·5	414	406·4	79·0	474	465·3	90·4	534	524·2	101·8	594	583·1	113·3
355	348·4	67·7	415	407·3	79·2	475	466·2	90·6	535	525·1	102·0	595	584·0	113·5
356	349·4	67·9	416	408·3	79·4	476	467·2	90·8	536	526·1	102·2	596	585·0	113·7
357	350·4	68·1	417	409·3	79·6	477	468·2	91·0	537	527·1	102·4	597	586·0	113·9
358	351·4	68·3	418	410·3	79·8	478	469·2	91·2	538	528·1	102·6	598	587·0	114·1
359	352·4	68·5	419	411·3	80·0	479	470·2	91·4	539	529·1	102·8	599	588·0	114·3
360	353·4	68·7	420	412·3	80·1	480	471·1	91·6	540	530·1	103·0	600	589·0	114·5
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

79° 5h 16m

TRAVERSE TABLE TO DEGREES

Dist.	D.Lat	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
						12°							0h 48m	
1	1·0	0·2	61	59·7	12·7	121	118·4	25·2	181	177·0	37·6	241	235·7	50·1
2	2·0	0·4	62	60·6	12·9	122	119·3	25·4	182	178·0	37·8	242	236·7	50·3
3	2·9	0·6	63	61·6	13·1	123	120·3	25·6	183	179·0	38·0	243	237·7	50·5
4	3·9	0·8	64	62·6	13·3	124	121·3	25·8	184	180·0	38·3	244	238·7	50·7
5	4·9	1·0	65	63·6	13·5	125	122·3	26·0	185	181·0	38·5	245	239·6	50·9
6	5·9	1·2	66	64·6	13·7	126	123·2	26·2	186	181·9	38·7	246	240·6	51·1
7	6·8	1·5	67	65·5	13·9	127	124·2	26·4	187	182·9	38·9	247	241·6	51·4
8	7·8	1·7	68	66·5	14·1	128	125·2	26·6	188	183·9	39·1	248	242·6	51·6
9	8·8	1·9	69	67·5	14·3	129	126·2	26·8	189	184·9	39·3	249	243·6	51·8
10	9·8	2·1	70	68·5	14·6	130	127·2	27·0	190	185·8	39·5	250	244·5	52·0
11	10·8	2·3	71	69·4	14·8	131	128·1	27·2	191	186·8	39·7	251	245·5	52·2
12	11·7	2·5	72	70·4	15·0	132	129·1	27·4	192	187·8	39·9	252	246·5	52·4
13	12·7	2·7	73	71·4	15·2	133	130·1	27·7	193	188·8	40·1	253	247·5	52·6
14	13·7	2·9	74	72·4	15·4	134	131·1	27·9	194	189·8	40·3	254	248·4	52·8
15	14·7	3·1	75	73·4	15·6	135	132·0	28·1	195	190·7	40·5	255	249·4	53·0
16	15·7	3·3	76	74·3	15·8	136	133·0	28·3	196	191·7	40·8	256	250·4	53·2
17	16·6	3·5	77	75·3	16·0	137	134·0	28·5	197	192·7	41·0	257	251·4	53·4
18	17·6	3·7	78	76·3	16·2	138	135·0	28·7	198	193·7	41·2	258	252·4	53·6
19	18·6	4·0	79	77·3	16·4	139	136·0	28·9	199	194·7	41·4	259	253·3	53·8
20	19·6	4·2	80	78·3	16·6	140	136·9	29·1	200	195·6	41·6	260	254·3	54·1
21	20·5	4·4	81	79·2	16·8	141	137·9	29·3	201	196·6	41·8	261	255·3	54·3
22	21·5	4·6	82	80·2	17·0	142	138·9	29·5	202	197·6	42·0	262	256·3	54·5
23	22·5	4·8	83	81·2	17·3	143	139·9	29·7	203	198·6	42·2	263	257·3	54·7
24	23·5	5·0	84	82·2	17·5	144	140·9	29·9	204	199·5	42·4	264	258·2	54·9
25	24·5	5·2	85	83·1	17·7	145	141·8	30·1	205	200·5	42·6	265	259·2	55·1
26	25·4	5·5	86	84·1	17·9	146	142·8	30·4	206	201·5	42·8	266	260·2	55·3
27	26·4	5·6	87	85·1	18·1	147	143·8	30·6	207	202·5	43·0	267	261·2	55·5
28	27·4	5·8	88	86·1	18·3	148	144·8	30·8	208	203·5	43·2	268	262·1	55·7
29	28·4	6·0	89	87·1	18·5	149	145·7	31·0	209	204·4	43·5	269	263·1	55·9
30	29·3	6·2	90	88·0	18·7	150	146·7	31·2	210	205·4	43·7	270	264·1	56·1
31	30·3	6·4	91	89·0	18·9	151	147·7	31·4	211	206·4	43·9	271	265·1	56·3
32	31·3	6·7	92	90·0	19·1	152	148·7	31·6	212	207·4	44·1	272	266·1	56·6
33	32·3	6·9	93	91·0	19·3	153	149·7	31·8	213	208·3	44·3	273	267·0	56·8
34	33·3	7·1	94	91·9	19·5	154	150·6	32·0	214	209·3	44·5	274	268·0	57·0
35	34·2	7·3	95	92·9	19·8	155	151·6	32·2	215	210·3	44·7	275	269·0	57·2
36	35·2	7·5	96	93·9	20·0	156	152·6	32·4	216	211·3	44·9	276	270·0	57·4
37	36·2	7·7	97	94·9	20·2	157	153·6	32·6	217	212·3	45·1	277	270·9	57·6
38	37·2	7·9	98	95·9	20·4	158	154·5	32·9	218	213·2	45·3	278	271·9	57·8
39	38·1	8·1	99	96·8	20·6	159	155·5	33·1	219	214·2	45·5	279	272·9	58·0
40	39·1	8·3	100	97·8	20·8	160	156·5	33·3	220	215·2	45·7	280	273·9	58·2
41	40·1	8·5	101	98·8	21·0	161	157·5	33·5	221	216·2	45·9	281	274·9	58·4
42	41·1	8·7	102	99·8	21·2	162	158·5	33·7	222	217·1	46·2	282	275·8	58·6
43	42·1	8·9	103	100·7	21·4	163	159·4	33·9	223	218·1	46·4	283	276·8	58·8
44	43·0	9·1	104	101·7	21·6	164	160·4	34·1	224	219·1	46·6	284	277·8	59·0
45	44·0	9·4	105	102·7	21·8	165	161·4	34·3	225	220·1	46·8	285	278·8	59·3
46	45·0	9·6	106	103·7	22·0	166	162·4	34·5	226	221·1	47·0	286	279·8	59·5
47	46·0	9·8	107	104·7	22·2	167	163·4	34·7	227	222·0	47·2	287	280·7	59·7
48	47·0	10·0	108	105·6	22·5	168	164·3	34·9	228	223·0	47·4	288	281·7	59·9
49	47·9	10·2	109	106·6	22·7	169	165·3	35·1	229	224·0	47·6	289	282·7	60·1
50	48·9	10·4	110	107·6	22·9	170	166·3	35·3	230	225·0	47·8	290	283·7	60·3
51	49·9	10·6	111	108·6	23·1	171	167·3	35·6	231	226·0	48·0	291	284·6	60·5
52	50·9	10·8	112	109·6	23·3	172	168·2	35·8	232	226·9	48·2	292	285·6	60·7
53	51·8	11·0	113	110·5	23·5	173	169·2	36·0	233	227·9	48·4	293	286·6	60·9
54	52·8	11·2	114	111·5	23·7	174	170·2	36·2	234	228·9	48·7	294	287·6	61·1
55	53·8	11·4	115	112·5	23·9	175	171·2	36·4	235	229·9	48·9	295	288·6	61·3
56	54·8	11·6	116	113·5	24·1	176	172·2	36·6	236	230·8	49·1	296	289·5	61·5
57	55·8	11·9	117	114·4	24·3	177	173·1	36·8	237	231·8	49·3	297	290·5	61·7
58	56·7	12·1	118	115·4	24·5	178	174·1	37·0	238	232·8	49·5	298	291·5	62·0
59	57·7	12·3	119	116·4	24·7	179	175·1	37·2	239	233·8	49·7	299	292·5	62·2
60	58·7	12·5	120	117·4	24·9	180	176·1	37·4	240	234·8	49·9	300	293·4	62·4
Dist.	Dep.	D.Lat	Dist.	Dep.	D.Lat	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat
						78°							5h 12m	

TRAVERSE TABLE TO DEGREES

12° 0h 48m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	294.4	62.6	361	353.1	75.0	421	411.8	87.5	481	470.5	100.0	541	529.2	112.5
302	295.4	62.8	362	354.1	75.2	422	412.8	87.7	482	471.5	100.2	542	530.2	112.7
303	296.4	63.0	363	355.1	75.4	423	413.8	87.9	483	472.5	100.4	543	531.1	112.9
304	297.4	63.2	364	356.0	75.7	424	414.7	88.1	484	473.4	100.6	544	532.1	113.1
305	298.3	63.4	365	357.0	75.9	425	415.7	88.3	485	474.4	100.8	545	533.1	113.3
306	299.3	63.6	366	358.0	76.1	426	416.7	88.6	486	475.4	101.0	546	534.1	113.5
307	300.3	63.8	367	359.0	76.3	427	417.7	88.8	487	476.4	101.2	547	535.1	113.7
308	301.3	64.0	368	360.0	76.5	428	418.6	89.0	488	477.3	101.4	548	536.0	113.9
309	302.2	64.2	369	360.9	76.7	429	419.6	89.2	489	478.3	101.6	549	537.0	114.1
310	303.2	64.4	370	361.9	76.9	430	420.6	89.4	490	479.3	101.9	550	538.0	114.4
311	304.2	64.6	371	362.9	77.1	431	421.6	89.6	491	480.3	102.1	551	538.9	114.6
312	305.2	64.8	372	363.9	77.3	432	422.6	89.8	492	481.2	102.3	552	539.9	114.8
313	306.2	65.1	373	364.8	77.5	433	423.5	90.0	493	482.2	102.5	553	540.9	115.0
314	307.1	65.3	374	365.8	77.7	434	424.5	90.2	494	483.2	102.7	554	541.9	115.2
315	308.1	65.5	375	366.8	77.9	435	425.5	90.4	495	484.2	102.9	555	542.9	115.4
316	309.1	65.7	376	367.8	78.2	436	426.5	90.6	496	485.2	103.1	556	543.8	115.6
317	310.1	65.9	377	368.8	78.4	437	427.5	90.8	497	486.1	103.3	557	544.8	115.8
318	311.1	66.1	378	369.7	78.6	438	428.4	91.0	498	487.1	103.5	558	545.8	116.0
319	312.0	66.3	379	370.7	78.8	439	429.4	91.3	499	488.1	103.8	559	546.8	116.2
320	313.0	66.5	380	371.7	79.0	440	430.4	91.5	500	489.1	104.0	560	547.8	116.4
321	314.0	66.7	381	372.7	79.2	441	431.4	91.7	501	490.0	104.2	561	548.7	116.6
322	315.0	66.9	382	373.7	79.4	442	432.3	91.9	502	491.0	104.4	562	549.7	116.8
323	315.9	67.1	383	374.6	79.6	443	433.3	92.1	503	492.0	104.6	563	550.7	117.0
324	316.9	67.3	384	375.6	79.8	444	434.3	92.3	504	493.0	104.8	564	551.7	117.2
325	317.9	67.6	385	376.6	80.0	445	435.3	92.5	505	494.0	105.0	565	552.7	117.4
326	318.9	67.8	386	377.6	80.2	446	436.3	92.7	506	495.0	105.2	566	553.7	117.6
327	319.9	68.0	387	378.5	80.4	447	437.2	92.9	507	495.9	105.4	567	554.6	117.8
328	320.8	68.2	388	379.5	80.7	448	438.2	93.1	508	496.9	105.6	568	555.6	118.0
329	321.8	68.4	389	380.5	80.9	449	439.2	93.3	509	497.9	105.8	569	556.6	118.2
330	322.8	68.6	390	381.5	81.1	450	440.2	93.5	510	498.9	106.0	570	557.5	118.5
331	323.8	68.8	391	382.5	81.3	451	441.1	93.7	511	499.8	106.2	571	558.5	118.7
332	324.7	69.0	392	383.4	81.5	452	442.1	93.9	512	500.8	106.4	572	559.5	118.9
333	325.7	69.2	393	384.4	81.7	453	443.1	94.1	513	501.8	106.6	573	560.5	119.1
334	326.7	69.4	394	385.4	81.9	454	444.1	94.4	514	502.8	106.8	574	561.5	119.3
335	327.7	69.6	395	386.4	82.1	455	445.1	94.6	515	503.7	107.0	575	562.4	119.5
336	328.7	69.8	396	387.3	82.3	456	446.0	94.8	516	504.7	107.2	576	563.4	119.7
337	329.6	70.0	397	388.3	82.5	457	447.0	95.0	517	505.7	107.4	577	564.4	119.9
338	330.6	70.3	398	389.3	82.7	458	448.0	95.2	518	506.7	107.6	578	565.4	120.1
339	331.6	70.5	399	390.3	82.9	459	449.0	95.4	519	507.7	107.8	579	566.4	120.3
340	332.6	70.7	400	391.3	83.1	460	450.0	95.6	520	508.7	108.1	580	567.4	120.6
341	333.5	70.9	401	392.2	83.4	461	450.9	95.8	521	509.6	108.3	581	568.3	120.8
342	334.5	71.1	402	393.2	83.6	462	451.9	96.0	522	510.6	108.5	582	569.3	121.0
343	335.5	71.3	403	394.2	83.8	463	452.9	96.2	523	511.6	108.7	583	570.3	121.2
344	336.5	71.5	404	395.2	84.0	464	453.9	96.5	524	512.5	108.9	584	571.2	121.4
345	337.5	71.7	405	396.2	84.2	465	454.8	96.7	525	513.5	109.2	585	572.2	121.6
346	338.4	71.9	406	397.1	84.4	466	455.8	96.9	526	514.5	109.4	586	573.2	121.8
347	339.4	72.1	407	398.1	84.6	467	456.8	97.1	527	515.5	109.6	587	574.2	122.0
348	340.4	72.3	408	399.1	84.8	468	457.8	97.3	528	516.5	109.8	588	575.2	122.2
349	341.4	72.5	409	400.1	85.0	469	458.8	97.5	529	517.5	110.0	589	576.2	122.4
350	342.4	72.7	410	401.0	85.2	470	459.7	97.7	530	518.4	110.2	590	577.1	122.6
351	343.3	73.0	411	402.0	85.4	471	460.7	97.9	531	519.4	110.4	591	578.1	122.8
352	344.3	73.2	412	403.0	85.6	472	461.7	98.1	532	520.4	110.6	592	579.1	123.0
353	345.3	73.4	413	404.0	85.8	473	462.7	98.3	533	521.3	110.8	593	580.0	123.2
354	346.3	73.6	414	405.0	86.1	474	463.6	98.5	534	522.3	111.0	594	581.0	123.4
355	347.2	73.8	415	405.9	86.3	475	464.6	98.7	535	523.3	111.2	595	582.0	123.6
356	348.2	74.0	416	406.9	86.5	476	465.6	98.9	536	524.3	111.4	596	583.0	123.9
357	349.2	74.2	417	407.9	86.7	477	466.6	99.1	537	525.3	111.6	597	584.0	124.1
358	350.2	74.4	418	408.9	86.9	478	467.6	99.4	538	526.2	111.8	598	584.9	124.3
359	351.2	74.6	419	409.8	87.1	479	468.5	99.6	539	527.2	112.0	599	585.9	124.5
360	352.1	74.8	420	410.8	87.3	480	469.5	99.8	540	528.2	112.3	600	586.9	124.7
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

78° 5h 12m

TRAVERSE TABLE TO DEGREES

13° 0h 52m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	1.0	0.2	61	59.4	13.7	121	117.9	27.2	181	176.4	40.7	241	234.8	54.2
2	1.9	0.4	62	60.4	13.9	122	118.9	27.4	182	177.3	40.9	242	235.8	54.4
3	2.9	0.7	63	61.4	14.2	123	119.8	27.7	183	178.3	41.2	243	236.8	54.7
4	3.9	0.9	64	62.4	14.4	124	120.8	27.9	184	179.3	41.4	244	237.7	54.9
5	4.9	1.1	65	63.3	14.6	125	121.8	28.1	185	180.3	41.6	245	238.7	55.1
6	5.8	1.3	66	64.3	14.8	126	122.8	28.3	186	181.2	41.8	246	239.7	55.3
7	6.8	1.6	67	65.3	15.1	127	123.7	28.6	187	182.2	42.1	247	240.7	55.6
8	7.8	1.8	68	66.3	15.3	128	124.7	28.8	188	183.2	42.3	248	241.6	55.8
9	8.8	2.0	69	67.2	15.5	129	125.7	29.0	189	184.2	42.5	249	242.6	56.0
10	9.7	2.2	70	68.2	15.7	130	126.7	29.2	190	185.1	42.7	250	243.6	56.2
11	10.7	2.5	71	69.2	16.0	131	127.6	29.5	191	186.1	43.0	251	244.6	56.5
12	11.7	2.7	72	70.2	16.2	132	128.6	29.7	192	187.1	43.2	252	245.5	56.7
13	12.7	2.9	73	71.1	16.4	133	129.6	29.9	193	188.1	43.4	253	246.5	56.9
14	13.6	3.1	74	72.1	16.6	134	130.6	30.1	194	189.0	43.6	254	247.5	57.1
15	14.6	3.4	75	73.1	16.9	135	131.5	30.4	195	190.0	43.9	255	248.5	57.4
16	15.6	3.6	76	74.1	17.1	136	132.5	30.6	196	191.0	44.1	256	249.4	57.6
17	16.6	3.8	77	75.0	17.3	137	133.5	30.8	197	192.0	44.3	257	250.4	57.8
18	17.5	4.0	78	76.0	17.5	138	134.5	31.0	198	192.9	44.5	258	251.4	58.0
19	18.5	4.3	79	77.0	17.8	139	135.4	31.3	199	193.9	44.8	259	252.4	58.3
20	19.5	4.5	80	78.0	18.0	140	136.4	31.5	200	194.9	45.0	260	253.3	58.5
21	20.5	4.7	81	78.9	18.2	141	137.4	31.7	201	195.8	45.2	261	254.3	58.7
22	21.4	4.9	82	79.9	18.4	142	138.4	31.9	202	196.8	45.4	262	255.3	58.9
23	22.4	5.2	83	80.9	18.7	143	139.3	32.2	203	197.8	45.7	263	256.3	59.2
24	23.4	5.4	84	81.8	18.9	144	140.3	32.4	204	198.8	45.9	264	257.2	59.4
25	24.4	5.6	85	82.8	19.1	145	141.3	32.6	205	199.7	46.1	265	258.2	59.6
26	25.3	5.8	86	83.8	19.3	146	142.3	32.8	206	200.7	46.3	266	259.2	59.8
27	26.3	6.1	87	84.8	19.6	147	143.2	33.1	207	201.7	46.6	267	260.2	60.1
28	27.3	6.3	88	85.7	19.8	148	144.2	33.3	208	202.7	46.8	268	261.1	60.3
29	28.3	6.5	89	86.7	20.0	149	145.2	33.5	209	203.6	47.0	269	262.1	60.5
30	29.2	6.7	90	87.7	20.2	150	146.2	33.7	210	204.6	47.2	270	263.1	60.7
31	30.2	7.0	91	88.7	20.5	151	147.1	34.0	211	205.6	47.5	271	264.1	61.0
32	31.2	7.2	92	89.6	20.7	152	148.1	34.2	212	206.6	47.7	272	265.0	61.2
33	32.2	7.4	93	90.6	20.9	153	149.1	34.4	213	207.5	47.9	273	266.0	61.4
34	33.1	7.6	94	91.6	21.1	154	150.1	34.6	214	208.5	48.1	274	267.0	61.6
35	34.1	7.9	95	92.6	21.4	155	151.0	34.9	215	209.5	48.4	275	268.0	61.9
36	35.1	8.1	96	93.5	21.6	156	152.0	35.1	216	210.5	48.6	276	268.9	62.1
37	36.1	8.3	97	94.5	21.8	157	153.0	35.3	217	211.4	48.8	277	269.9	62.3
38	37.0	8.5	98	95.5	22.0	158	154.0	35.5	218	212.4	49.0	278	270.9	62.5
39	38.0	8.8	99	96.5	22.3	159	154.9	35.8	219	213.4	49.3	279	271.8	62.8
40	39.0	9.0	100	97.4	22.5	160	155.9	36.0	220	214.4	49.5	280	272.8	63.0
41	39.9	9.2	101	98.4	22.7	161	156.9	36.2	221	215.3	49.7	281	273.8	63.2
42	40.9	9.4	102	99.4	22.9	162	157.8	36.4	222	216.3	49.9	282	274.8	63.4
43	41.9	9.7	103	100.4	23.2	163	158.8	36.7	223	217.3	50.2	283	275.7	63.7
44	42.9	9.9	104	101.3	23.4	164	159.8	36.9	224	218.3	50.4	284	276.7	63.9
45	43.8	10.1	105	102.3	23.6	165	160.8	37.1	225	219.2	50.6	285	277.7	64.1
46	44.8	10.3	106	103.3	23.8	166	161.7	37.3	226	220.2	50.8	286	278.7	64.3
47	45.8	10.6	107	104.3	24.1	167	162.7	37.6	227	221.2	51.1	287	279.6	64.6
48	46.8	10.8	108	105.2	24.3	168	163.7	37.8	228	222.2	51.3	288	280.6	64.8
49	47.7	11.0	109	106.2	24.5	169	164.7	38.0	229	223.1	51.5	289	281.6	65.0
50	48.7	11.2	110	107.2	24.7	170	165.6	38.2	230	224.1	51.7	290	282.6	65.2
51	49.7	11.5	111	108.2	25.0	171	166.6	38.5	231	225.1	52.0	291	283.5	65.5
52	50.7	11.7	112	109.1	25.2	172	167.6	38.7	232	226.1	52.2	292	284.5	65.7
53	51.6	11.9	113	110.1	25.4	173	168.6	38.9	233	227.0	52.4	293	285.5	65.9
54	52.6	12.1	114	111.1	25.6	174	169.5	39.1	234	228.0	52.6	294	286.5	66.1
55	53.6	12.4	115	112.1	25.9	175	170.5	39.4	235	229.0	52.9	295	287.4	66.4
56	54.6	12.6	116	113.0	26.1	176	171.5	39.6	236	230.0	53.1	296	288.4	66.6
57	55.5	12.8	117	114.0	26.3	177	172.5	39.8	237	230.9	53.3	297	289.4	66.8
58	56.5	13.0	118	115.0	26.5	178	173.4	40.0	238	231.9	53.5	298	290.4	67.0
59	57.5	13.3	119	116.0	26.8	179	174.4	40.3	239	232.9	53.8	299	291.3	67.3
60	58.5	13.5	120	116.9	27.0	180	175.4	40.5	240	233.8	54.0	300	292.3	67.5
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

77° 5h 8m

TRAVERSE TABLE TO DEGREES

13° 0h 52m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	293·3	67·7	361	351·8	81·2	421	410·2	94·7	481	468·7	108·2	541	527·2	121·7
302	294·3	67·9	362	352·7	81·4	422	411·2	94·9	482	469·7	108·4	542	528·1	121·9
303	295·2	68·1	363	353·7	81·6	423	412·2	95·1	483	470·6	108·6	543	529·1	122·1
304	296·2	68·4	364	354·7	81·9	424	413·1	95·3	484	471·6	108·8	544	530·1	122·3
305	297·2	68·6	365	355·6	82·1	425	414·1	95·6	485	472·6	109·0	545	531·1	122·5
306	298·2	68·8	366	356·6	82·3	426	415·1	95·8	486	473·6	109·3	546	532·0	122·8
307	299·1	69·0	367	357·6	82·5	427	416·1	96·0	487	474·5	109·5	547	533·0	123·0
308	300·1	69·3	368	358·6	82·8	428	417·0	96·2	488	475·5	109·7	548	534·0	123·2
309	301·1	69·5	369	359·5	83·0	429	418·0	96·5	489	476·5	109·9	549	535·0	123·4
310	302·1	69·7	370	360·5	83·2	430	419·0	96·7	490	477·5	110·1	550	535·9	123·7
311	303·0	69·9	371	361·5	83·4	431	420·0	96·9	491	478·4	110·4	551	536·9	123·9
312	304·0	70·2	372	362·5	83·7	432	420·9	97·1	492	479·4	110·6	552	537·9	124·1
313	305·0	70·4	373	363·4	83·9	433	421·9	97·4	493	480·4	110·9	553	538·9	124·4
314	306·0	70·6	374	364·4	84·1	434	422·9	97·6	494	481·4	111·1	554	539·8	124·6
315	306·9	70·8	375	365·4	84·3	435	423·9	97·8	495	482·3	111·3	555	540·8	124·9
316	307·9	71·1	376	366·4	84·6	436	424·8	98·0	496	483·3	111·5	556	541·8	125·1
317	308·9	71·3	377	367·3	84·8	437	425·8	98·3	497	484·3	111·8	557	542·8	125·3
318	309·9	71·5	378	368·3	85·0	438	426·8	98·5	498	485·3	112·0	558	543·7	125·5
319	310·8	71·7	379	369·3	85·2	439	427·8	98·7	499	486·2	112·2	559	544·7	125·8
320	311·8	72·0	380	370·3	85·5	440	428·7	98·9	500	487·2	112·4	560	545·7	126·0
321	312·8	72·2	381	371·2	85·7	441	429·7	99·2	501	488·2	112·6	561	546·7	126·2
322	313·8	72·4	382	372·2	85·9	442	430·7	99·4	502	489·2	112·9	562	547·6	126·4
323	314·7	72·6	383	373·2	86·1	443	431·6	99·6	503	490·1	113·1	563	548·6	126·7
324	315·7	72·9	384	374·2	86·4	444	432·6	99·8	504	491·1	113·3	564	549·6	126·9
325	316·7	73·1	385	375·1	86·6	445	433·6	100·1	505	492·1	113·5	565	550·6	127·1
326	317·6	73·3	386	376·1	86·8	446	434·6	100·3	506	493·1	113·8	566	551·5	127·3
327	318·6	73·5	387	377·1	87·0	447	435·5	100·5	507	494·0	114·0	567	552·5	127·6
328	319·6	73·8	388	378·1	87·3	448	436·5	100·7	508	495·0	114·2	568	553·5	127·8
329	320·6	74·0	389	379·0	87·5	449	437·5	101·0	509	496·0	114·5	569	554·5	128·0
330	321·5	74·2	390	380·0	87·7	450	438·5	101·2	510	496·9	114·7	570	555·4	128·3
331	322·5	74·4	391	381·0	87·9	451	439·4	101·4	511	497·9	114·9	571	556·4	128·5
332	323·5	74·7	392	382·0	88·2	452	440·4	101·6	512	498·9	115·1	572	557·4	128·7
333	324·5	74·9	393	382·9	88·4	453	441·4	101·9	513	499·9	115·4	573	558·4	128·9
334	325·4	75·1	394	383·9	88·6	454	442·4	102·1	514	500·8	115·6	574	559·3	129·2
335	326·4	75·3	395	384·9	88·8	455	443·3	102·3	515	501·8	115·8	575	560·3	129·4
336	327·4	75·6	396	385·9	89·1	456	444·3	102·5	516	502·8	116·0	576	561·3	129·6
337	328·4	75·8	397	386·8	89·3	457	445·3	102·8	517	503·8	116·3	577	562·3	129·8
338	329·3	76·0	398	387·8	89·5	458	446·3	103·0	518	504·7	116·5	578	563·2	130·0
339	330·3	76·2	399	388·8	89·7	459	447·2	103·2	519	505·7	116·7	579	564·2	130·2
340	331·3	76·5	400	389·8	90·0	460	448·2	103·4	520	506·7	116·9	580	565·2	130·4
341	332·3	76·7	401	390·7	90·2	461	449·2	103·7	521	507·7	117·2	581	566·2	130·7
342	333·2	76·9	402	391·7	90·4	462	450·2	103·9	522	508·6	117·5	582	567·1	131·0
343	334·2	77·1	403	392·7	90·6	463	451·1	104·1	523	509·6	117·7	583	568·1	131·2
344	335·2	77·4	404	393·6	90·8	464	452·1	104·3	524	510·6	117·9	584	569·1	131·4
345	336·2	77·6	405	394·6	91·1	465	453·1	104·6	525	511·6	118·1	585	570·1	131·6
346	337·1	77·8	406	395·6	91·3	466	454·1	104·8	526	512·5	118·3	586	571·0	131·8
347	338·1	78·0	407	396·6	91·5	467	455·0	105·0	527	513·5	118·5	587	572·0	132·0
348	339·1	78·3	408	397·5	91·7	468	456·0	105·2	528	514·5	118·7	588	573·0	132·3
349	340·1	78·5	409	398·5	92·0	469	457·0	105·5	529	515·5	119·0	589	573·9	132·5
350	341·0	78·7	410	399·5	92·2	470	458·0	105·7	530	516·4	119·2	590	574·9	132·8
351	342·0	78·9	411	400·5	92·4	471	458·9	105·9	531	517·4	119·4	591	575·9	133·0
352	343·0	79·2	412	401·4	92·6	472	459·9	106·1	532	518·4	119·6	592	576·9	133·2
353	344·0	79·4	413	402·4	92·9	473	460·9	106·4	533	519·4	119·9	593	577·8	133·4
354	344·9	79·6	414	403·4	93·1	474	461·9	106·6	534	520·3	120·1	594	578·8	133·6
355	345·9	79·8	415	404·4	93·3	475	462·8	106·8	535	521·3	120·3	595	579·8	133·8
356	346·9	80·1	416	405·3	93·5	476	463·8	107·0	536	522·3	120·5	596	580·8	134·0
357	347·9	80·3	417	406·3	93·8	477	464·8	107·3	537	523·3	120·8	597	581·7	134·3
358	348·8	80·5	418	407·3	94·0	478	465·8	107·5	538	524·2	121·0	598	582·7	134·5
359	349·8	80·7	419	408·3	94·2	479	466·7	107·7	539	525·2	121·2	599	583·7	134·8
360	350·8	81·0	420	409·2	94·4	480	467·7	107·9	540	526·2	121·5	600	584·6	135·0
Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat	Dist	Dep.	D. Lat	Dist	Dep.	D. Lat	Dist.	Dep.	D. Lat

77° 5h 8m

TRAVERSE TABLE TO DEGREES

14° — $0^h\ 56^m$

Dist.	D.Lat	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	1·0	0·2	61	59·2	14·8	121	117·4	29·3	181	175·6	43·8	241	233·8	58·3
2	1·9	0·5	62	60·2	15·0	122	118·4	29·5	182	176·6	44·0	242	234·8	58·5
3	2·9	0·7	63	61·1	15·2	123	119·3	29·8	183	177·6	44·3	243	235·8	58·8
4	3·9	1·0	64	62·1	15·5	124	120·3	30·0	184	178·5	44·5	244	236·8	59·0
5	4·9	1·2	65	63·1	15·7	125	121·3	30·2	185	179·5	44·8	245	237·7	59·3
6	5·8	1·5	66	64·0	16·0	126	122·3	30·5	186	180·5	45·0	246	238·7	59·5
7	6·8	1·7	67	65·0	16·2	127	123·2	30·7	187	181·4	45·2	247	239·7	59·8
8	7·8	1·9	68	66·0	16·5	128	124·2	31·0	188	182·4	45·5	248	240·6	60·0
9	8·7	2·2	69	67·0	16·7	129	125·2	31·2	189	183·4	45·7	249	241·6	60·2
10	9·7	2·4	70	67·9	16·9	130	126·1	31·4	190	184·4	46·0	250	242·6	60·5
11	10·7	2·7	71	68·9	17·2	131	127·1	31·7	191	185·3	46·2	251	243·5	60·7
12	11·6	2·9	72	69·9	17·4	132	128·1	31·9	192	186·3	46·4	252	244·5	61·0
13	12·6	3·1	73	70·8	17·7	133	129·0	32·2	193	187·3	46·7	253	245·5	61·2
14	13·6	3·4	74	71·8	17·9	134	130·0	32·4	194	188·2	46·9	254	246·5	61·4
15	14·6	3·6	75	72·8	18·1	135	131·0	32·7	195	189·2	47·2	255	247·4	61·7
16	15·5	3·9	76	73·7	18·4	136	132·0	32·9	196	190·2	47·4	256	248·4	61·9
17	16·5	4·1	77	74·7	18·6	137	132·9	33·1	197	191·1	47·7	257	249·4	62·2
18	17·5	4·4	78	75·7	18·9	138	133·9	33·4	198	192·1	47·9	258	250·3	62·4
19	18·4	4·6	79	76·7	19·1	139	134·9	33·6	199	193·1	48·1	259	251·3	62·7
20	19·4	4·8	80	77·6	19·4	140	135·8	33·9	200	194·1	48·4	260	252·3	62·9
21	20·4	5·1	81	78·6	19·6	141	136·8	34·1	201	195·0	48·6	261	253·2	63·1
22	21·3	5·3	82	79·6	19·8	142	137·8	34·4	202	196·0	48·9	262	254·2	63·4
23	22·3	5·6	83	80·5	20·1	143	138·8	34·6	203	197·0	49·1	263	255·2	63·6
24	23·3	5·8	84	81·5	20·3	144	139·7	34·8	204	197·9	49·4	264	256·2	63·9
25	24·3	6·0	85	82·5	20·6	145	140·7	35·1	205	198·9	49·6	265	257·1	64·1
26	25·2	6·3	86	83·4	20·8	146	141·7	35·3	206	199·9	49·8	266	258·1	64·4
27	26·2	6·5	87	84·4	21·0	147	142·6	35·6	207	200·9	50·1	267	259·1	64·6
28	27·2	6·8	88	85·4	21·3	148	143·6	35·8	208	201·8	50·3	268	260·0	64·8
29	28·1	7·0	89	86·4	21·5	149	144·6	36·0	209	202·8	50·6	269	261·0	65·1
30	29·1	7·3	90	87·3	21·8	150	145·5	36·3	210	203·8	50·8	270	262·0	65·3
31	30·1	7·5	91	88·3	22·0	151	146·5	36·5	211	204·7	51·0	271	263·0	65·6
32	31·0	7·7	92	89·3	22·3	152	147·5	36·8	212	205·7	51·3	272	263·9	65·8
33	32·0	8·0	93	90·2	22·5	153	148·5	37·0	213	206·7	51·5	273	264·9	66·0
34	33·0	8·2	94	91·2	22·7	154	149·4	37·3	214	207·6	51·8	274	265·9	66·3
35	34·0	8·5	95	92·2	23·0	155	150·4	37·5	215	208·6	52·0	275	266·8	66·5
36	34·9	8·7	96	93·1	23·2	156	151·4	37·7	216	209·6	52·3	276	267·8	66·8
37	35·9	9·0	97	94·1	23·5	157	152·3	38·0	217	210·6	52·5	277	268·8	67·0
38	36·9	9·2	98	95·1	23·7	158	153·3	38·2	218	211·5	52·7	278	269·7	67·3
39	37·8	9·4	99	96·1	24·0	159	154·3	38·5	219	212·5	53·0	279	270·7	67·5
40	38·8	9·7	100	97·0	24·2	160	155·2	38·7	220	213·5	53·2	280	271·7	67·7
41	39·8	9·9	101	98·0	24·4	161	156·2	38·9	221	214·4	53·5	281	272·7	68·0
42	40·8	10·2	102	99·0	24·7	162	157·2	39·2	222	215·4	53·7	282	273·6	68·2
43	41·7	10·4	103	99·9	24·9	163	158·2	39·4	223	216·4	53·9	283	274·6	68·5
44	42·7	10·6	104	100·9	25·2	164	159·1	39·7	224	217·3	54·2	284	275·6	68·7
45	43·7	10·9	105	101·9	25·4	165	160·1	39·9	225	218·3	54·4	285	276·5	68·9
46	44·6	11·1	106	102·9	25·6	166	161·1	40·2	226	219·3	54·7	286	277·5	69·2
47	45·6	11·4	107	103·8	25·9	167	162·0	40·4	227	220·3	54·9	287	278·5	69·4
48	46·6	11·6	108	104·8	26·1	168	163·0	40·6	228	221·2	55·2	288	279·4	69·7
49	47·5	11·9	109	105·8	26·4	169	164·0	40·9	229	222·2	55·4	289	280·4	69·9
50	48·5	12·1	110	106·7	26·6	170	165·0	41·1	230	223·2	55·6	290	281·4	70·2
51	49·5	12·3	111	107·7	26·9	171	165·9	41·4	231	224·1	55·9	291	282·4	70·4
52	50·5	12·6	112	108·7	27·1	172	166·9	41·6	232	225·1	56·1	292	283·3	70·6
53	51·4	12·8	113	109·6	27·3	173	167·9	41·9	233	226·1	56·4	293	284·3	70·9
54	52·4	13·1	114	110·6	27·6	174	168·8	42·1	234	227·0	56·6	294	285·3	71·1
55	53·4	13·3	115	111·6	27·8	175	169·8	42·3	235	228·0	56·9	295	286·2	71·4
56	54·3	13·5	116	112·6	28·1	176	170·8	42·6	236	229·0	57·1	296	287·2	71·6
57	55·3	13·8	117	113·5	28·3	177	171·7	42·8	237	230·0	57·3	297	288·2	71·9
58	56·3	14·0	118	114·5	28·5	178	172·7	43·1	238	230·9	57·6	298	289·1	72·1
59	57·2	14·3	119	115·5	28·8	179	173·7	43·3	239	231·9	57·8	299	290·1	72·3
60	58·2	14·5	120	116·4	29·0	180	174·7	43·5	240	232·9	58·1	300	291·1	72·6
Dist.	Dep.	D.Lat	Dist.	Dep.	D.Lat	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat.

76° — $5^h\ 4^m$

TRAVERSE TABLE TO DEGREES

14° 0h 56m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	292·0	72·8	361	350·2	87·3	421	408·5	101·8	481	466·7	116·3	541	525·0	130·9
302	293·0	73·0	362	351·2	87·6	422	409·4	102·1	482	467·7	116·6	542	525·9	131·2
303	294·0	73·3	363	352·2	87·8	423	410·4	102·3	483	468·6	116·8	543	526·9	131·4
304	294·9	73·5	364	353·2	88·0	424	411·4	102·6	484	469·6	117·1	544	527·9	131·6
305	295·9	73·8	365	354·1	88·3	425	412·3	102·8	485	470·6	117·3	545	528·8	131·9
306	296·9	74·0	366	355·1	88·5	426	413·3	103·0	486	471·5	117·6	546	529·8	132·1
307	297·8	74·2	367	356·1	88·8	427	414·3	103·3	487	472·5	117·8	547	530·8	132·3
308	298·8	74·5	368	357·0	89·0	428	415·3	103·5	488	473·5	118·0	548	531·7	132·6
309	299·8	74·7	369	358·0	89·2	429	416·2	103·8	489	474·5	118·3	549	532·7	132·8
310	300·8	75·0	370	359·0	89·5	430	417·2	104·0	490	475·4	118·5	550	533·7	133·0
311	301·7	75·2	371	359·9	89·7	431	418·2	104·2	491	476·4	118·8	551	534·6	133·3
312	302·7	75·5	372	360·9	90·0	432	419·1	104·5	492	477·4	119·0	552	535·6	133·6
313	303·7	75·7	373	361·9	90·2	433	420·1	104·7	493	478·3	119·2	553	536·6	133·8
314	304·6	75·9	374	362·9	90·5	434	421·1	105·0	494	479·3	119·5	554	537·5	134·0
315	305·6	76·2	375	363·8	90·7	435	422·0	105·2	495	480·3	119·7	555	538·5	134·3
316	306·6	76·4	376	364·8	90·9	436	423·0	105·5	496	481·3	120·0	556	539·5	134·5
317	307·6	76·7	377	365·8	91·2	437	424·0	105·7	497	482·2	120·2	557	540·5	134·8
318	308·5	76·9	378	366·7	91·4	438	425·0	105·9	498	483·2	120·4	558	541·4	135·0
319	309·5	77·2	379	367·7	91·7	439	425·9	106·2	499	484·2	120·7	559	542·4	135·2
320	310·5	77·4	380	368·7	91·9	440	426·9	106·4	500	485·1	121·0	560	543·4	135·5
321	311·4	77·6	381	369·6	92·2	441	427·9	106·7	501	486·1	121·2	561	544·3	135·7
322	312·4	77·9	382	370·6	92·4	442	428·8	106·9	502	487·1	121·4	562	545·3	135·9
323	313·4	78·1	383	371·6	92·6	443	429·8	107·1	503	488·0	121·7	563	546·3	136·2
324	314·3	78·4	384	372·6	92·9	444	430·8	107·4	504	489·0	122·0	564	547·2	136·5
325	315·3	78·6	385	373·5	93·1	445	431·7	107·6	505	490·0	122·1	565	548·2	136·6
326	316·3	78·8	386	374·5	93·4	446	432·7	107·9	506	491·0	122·4	566	549·2	136·9
327	317·3	79·1	387	375·5	93·6	447	433·7	108·1	507	491·9	122·6	567	550·1	137·1
328	318·2	79·3	388	376·4	93·8	448	434·7	108·4	508	492·9	122·9	568	551·1	137·4
329	319·2	79·6	389	377·4	94·1	449	435·6	108·6	509	493·9	123·1	569	552·1	137·6
330	320·2	79·8	390	378·4	94·3	450	436·6	108·8	510	494·9	123·4	570	553·1	137·9
331	321·1	80·1	391	379·4	94·6	451	437·6	109·1	511	495·8	123·6	571	554·0	138·1
332	322·1	80·3	392	380·3	94·8	452	438·5	109·3	512	496·8	123·8	572	555·0	138·3
333	323·1	80·5	393	381·3	95·1	453	439·5	109·6	513	497·8	124·1	573	556·0	138·6
334	324·0	80·8	394	382·3	95·3	454	440·5	109·8	514	498·7	124·3	574	557·0	138·8
335	325·0	81·0	395	383·2	95·5	455	441·5	110·1	515	499·7	124·6	575	557·9	139·1
336	326·0	81·3	396	384·2	95·8	456	442·4	110·3	516	500·7	124·8	576	558·9	139·3
337	327·0	81·5	397	385·2	96·0	457	443·4	110·5	517	501·7	125·0	577	559·9	139·5
338	327·9	81·7	398	386·1	96·3	458	444·4	110·8	518	502·6	125·3	578	560·9	139·8
339	328·9	82·0	399	387·1	96·5	459	445·3	111·0	519	503·6	125·6	579	561·8	140·0
340	329·9	82·2	400	388·1	96·7	460	446·3	111·3	520	504·6	125·8	580	562·8	140·3
341	330·8	82·5	401	389·1	97·0	461	447·3	111·5	521	505·5	126·0	581	563·8	140·5
342	331·8	82·7	402	390·0	97·2	462	448·2	111·7	522	506·5	126·2	582	564·7	140·8
343	332·8	83·0	403	391·0	97·5	463	449·2	112·0	523	507·5	126·5	583	565·7	141·0
344	333·7	83·2	404	392·0	97·7	464	450·2	112·2	524	508·4	126·8	584	566·7	141·3
345	334·7	83·4	405	392·9	98·0	465	451·2	112·5	525	509·4	127·0	585	567·6	141·5
346	335·7	83·7	406	393·9	98·2	466	452·1	112·7	526	510·4	127·2	586	568·6	141·8
347	336·7	83·9	407	394·9	98·4	467	453·1	113·0	527	511·4	127·5	587	569·6	142·0
348	337·6	84·2	408	395·8	98·7	468	454·1	113·2	528	512·3	127·8	588	570·6	142·3
349	338·6	84·4	409	396·8	98·9	469	455·0	113·4	529	513·3	128·0	589	571·5	142·5
350	339·6	84·7	410	397·8	99·2	470	456·0	113·7	530	514·3	128·2	590	572·5	142·8
351	340·5	84·9	411	398·8	99·4	471	457·0	113·9	531	515·3	128·5	591	573·5	143·0
352	341·5	85·1	412	399·7	99·7	472	457·9	114·2	532	516·2	128·8	592	574·4	143·3
353	342·5	85·4	413	400·7	99·9	473	458·9	114·4	533	517·2	129·0	593	575·4	143·5
354	343·5	85·6	414	401·7	100·1	474	459·9	114·6	534	518·2	129·2	594	576·4	143·8
355	344·4	85·9	415	402·6	100·4	475	460·9	114·9	535	519·1	129·4	595	577·3	144·0
356	345·4	86·1	416	403·6	100·6	476	461·8	115·1	536	520·1	129·7	596	578·3	144·2
357	346·4	86·3	417	404·6	100·9	477	462·8	115·4	537	521·1	129·9	597	579·3	144·5
358	347·3	86·6	418	405·5	101·1	478	463·8	115·6	538	522·1	130·2	598	580·3	144·7
359	348·3	86·8	419	406·5	101·3	479	464·7	115·9	539	523·0	130·4	599	581·2	144·9
360	349·3	87·1	420	407·5	101·6	480	465·7	116·1	540	524·0	130·6	600	582·2	145·1
Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

76° 5h 4m

TRAVERSE TABLE TO DEGREES

16°														1h 4m
Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	1·0	0·3	61	58·6	16·8	121	116·3	33·4	181	174·0	49·9	241	231·7	66·4
2	1·9	0·6	62	59·6	17·1	122	117·3	33·6	182	174·9	50·2	242	232·6	66·7
3	2·9	0·8	63	60·6	17·4	123	118·2	33·9	183	175·9	50·4	243	233·6	67·0
4	3·8	1·1	64	61·5	17·6	124	119·2	34·2	184	176·9	50·7	244	234·5	67·3
5	4·8	1·4	65	62·5	17·9	125	120·2	34·5	185	177·8	51·0	245	235·5	67·5
6	5·8	1·7	66	63·4	18·2	126	121·1	34·7	186	178·8	51·3	246	236·5	67·8
7	6·7	1·9	67	64·4	18·5	127	122·1	35·0	187	179·8	51·5	247	237·4	68·1
8	7·7	2·2	68	65·4	18·7	128	123·0	35·3	188	180·7	51·8	248	238·4	68·4
9	8·7	2·5	69	66·3	19·0	129	124·0	35·6	189	181·7	52·1	249	239·4	68·6
10	9·6	2·8	70	67·3	19·3	130	125·0	35·8	190	182·6	52·4	250	240·3	68·9
11	10·6	3·0	71	68·2	19·6	131	125·9	36·1	191	183·6	52·6	251	241·3	69·2
12	11·5	3·3	72	69·2	19·8	132	126·9	36·4	192	184·6	52·9	252	242·2	69·5
13	12·5	3·6	73	70·2	20·1	133	127·8	36·7	193	185·5	53·2	253	243·2	69·7
14	13·5	3·9	74	71·1	20·4	134	128·8	36·9	194	186·5	53·5	254	244·2	70·0
15	14·4	4·1	75	72·1	20·7	135	129·8	37·2	195	187·4	53·7	255	245·1	70·3
16	15·4	4·4	76	73·1	20·9	136	130·7	37·5	196	188·4	54·0	256	246·1	70·6
17	16·3	4·7	77	74·0	21·2	137	131·7	37·8	197	189·4	54·3	257	247·0	70·8
18	17·3	5·0	78	75·0	21·5	138	132·7	38·0	198	190·3	54·6	258	248·0	71·1
19	18·3	5·2	79	75·9	21·8	139	133·6	38·3	199	191·3	54·9	259	249·0	71·4
20	19·2	5·5	80	76·9	22·1	140	134·6	38·6	200	192·3	55·1	260	249·9	71·7
21	20·2	5·8	81	77·9	22·3	141	135·5	38·9	201	193·2	55·4	261	250·9	71·9
22	21·1	6·1	82	78·8	22·6	142	136·5	39·1	202	194·2	55·7	262	251·9	72·2
23	22·1	6·3	83	79·8	22·9	143	137·5	39·4	203	195·1	56·0	263	252·8	72·5
24	23·1	6·6	84	80·7	23·2	144	138·4	39·7	204	196·1	56·2	264	253·8	72·8
25	24·0	6·9	85	81·7	23·4	145	139·4	40·0	205	197·1	56·5	265	254·7	73·0
26	25·0	7·2	86	82·7	23·7	146	140·3	40·2	206	198·0	56·8	266	255·7	73·3
27	26·0	7·4	87	83·6	24·0	147	141·3	40·5	207	199·0	57·1	267	256·7	73·6
28	26·9	7·7	88	84·6	24·3	148	142·3	40·8	208	199·9	57·3	268	257·6	73·9
29	27·9	8·0	89	85·6	24·5	149	143·2	41·1	209	200·9	57·6	269	258·6	74·1
30	28·8	8·3	90	86·5	24·8	150	144·2	41·3	210	201·9	57·9	270	259·5	74·4
31	29·8	8·5	91	87·5	25·1	151	145·2	41·6	211	202·8	58·2	271	260·5	74·7
32	30·8	8·8	92	88·4	25·4	152	146·1	41·9	212	203·8	58·4	272	261·5	75·0
33	31·7	9·1	93	89·4	25·6	153	147·1	42·2	213	204·7	58·7	273	262·4	75·2
34	32·7	9·4	94	90·4	25·9	154	148·0	42·4	214	205·7	59·0	274	263·4	75·5
35	33·6	9·6	95	91·3	26·2	155	149·0	42·7	215	206·7	59·3	275	264·3	75·8
36	34·6	9·9	96	92·3	26·5	156	150·0	43·0	216	207·6	59·5	276	265·3	76·1
37	35·6	10·2	97	93·2	26·7	157	150·9	43·3	217	208·6	59·8	277	266·3	76·4
38	36·5	10·5	98	94·2	27·0	158	151·9	43·6	218	209·6	60·1	278	267·2	76·6
39	37·5	10·7	99	95·2	27·3	159	152·8	43·8	219	210·5	60·4	279	268·2	76·9
40	38·5	11·0	100	96·1	27·6	160	153·8	44·1	220	211·5	60·6	280	269·2	77·2
41	39·4	11·3	101	97·1	27·8	161	154·8	44·4	221	212·4	60·9	281	270·1	77·5
42	40·4	11·6	102	98·0	28·1	162	155·7	44·7	222	213·4	61·2	282	271·1	77·7
43	41·3	11·9	103	99·0	28·4	163	156·7	44·9	223	214·4	61·5	283	272·0	78·0
44	42·3	12·1	104	100·0	28·7	164	157·6	45·2	224	215·3	61·7	284	273·0	78·3
45	43·3	12·4	105	100·9	28·9	165	158·6	45·5	225	216·3	62·0	285	274·0	78·6
46	44·2	12·7	106	101·9	29·2	166	159·6	45·8	226	217·3	62·3	286	274·9	78·8
47	45·2	13·0	107	102·9	29·5	167	160·5	46·0	227	218·2	62·6	287	275·9	79·1
48	46·1	13·2	108	103·8	29·8	168	161·5	46·3	228	219·2	62·8	288	276·8	79·4
49	47·1	13·5	109	104·8	30·0	169	162·5	46·6	229	220·1	63·1	289	277·8	79·7
50	48·1	13·8	110	105·7	30·3	170	163·4	46·9	230	221·1	63·4	290	278·8	79·9
51	49·0	14·1	111	106·7	30·6	171	164·4	47·1	231	222·1	63·7	291	279·7	80·2
52	50·0	14·3	112	107·7	30·9	172	165·3	47·4	232	223·0	63·9	292	280·7	80·5
53	50·9	14·6	113	108·6	31·1	173	166·3	47·7	233	224·0	64·2	293	281·6	80·8
54	51·9	14·9	114	109·6	31·4	174	167·3	48·0	234	224·9	64·5	294	282·6	81·0
55	52·9	15·2	115	110·5	31·7	175	168·2	48·2	235	225·9	64·8	295	283·6	81·3
56	53·8	15·4	116	111·5	32·0	176	169·2	48·5	236	226·9	65·1	296	284·5	81·6
57	54·8	15·7	117	112·5	32·2	177	170·1	48·8	237	227·8	65·3	297	285·5	81·9
58	55·8	16·0	118	113·4	32·5	178	171·1	49·1	238	228·8	65·6	298	286·5	82·1
59	56·7	16·3	119	114·4	32·8	179	172·1	49·3	239	229·7	65·9	299	287·4	82·4
60	57·7	16·5	120	115·4	33·1	180	173·0	49·6	240	230·7	66·2	300	288·4	82·7
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.
74°														4h 56m

TRAVERSE TABLE TO DEGREES

16° 1ʰ 4ᵐ

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	289·3	82·9	361	347·0	99·5	421	404·7	116·0	481	462·4	132·5	541	520·1	149·1
302	290·3	83·2	362	348·0	99·7	422	405·6	116·3	482	463·3	132·8	542	521·0	149·4
303	291·2	83·5	363	348·9	100·0	423	406·6	116·6	483	464·3	133·1	543	522·0	149·7
304	292·2	83·8	364	349·9	100·3	424	407·6	116·8	484	465·2	133·4	544	523·0	150·0
305	293·2	84·0	365	350·8	100·6	425	408·5	117·1	485	466·2	133·6	545	523·9	150·2
306	294·1	84·3	366	351·8	100·8	426	409·5	117·4	486	467·2	133·9	546	524·9	150·4
307	295·1	84·6	367	352·8	101·1	427	410·4	117·7	487	468·1	134·2	547	525·9	150·7
308	296·0	84·9	368	353·7	101·4	428	411·4	117·9	488	469·1	134·5	548	526·8	151·0
309	297·0	85·1	369	354·7	101·7	429	412·4	118·2	489	470·1	134·8	549	527·8	151·3
310	298·0	85·4	370	355·6	101·9	430	413·3	118·5	490	471·0	135·0	550	528·7	151·6
311	298·9	85·7	371	356·6	102·2	431	414·3	118·8	491	472·0	135·3	551	529·7	151·9
312	299·9	86·0	372	357·6	102·5	432	415·2	119·0	492	472·9	135·6	552	530·6	152·2
313	300·9	86·2	373	358·5	102·8	433	416·2	119·3	493	473·9	135·9	553	531·6	152·5
314	301·8	86·5	374	359·5	103·1	434	417·2	119·6	494	474·9	136·2	554	532·6	152·8
315	302·8	86·8	375	360·4	103·3	435	418·1	119·9	495	475·8	136·4	555	533·5	153·0
316	303·7	87·1	376	361·4	103·6	436	419·1	120·1	496	476·8	136·7	556	534·5	153·2
317	304·7	87·3	377	362·4	103·9	437	420·0	120·4	497	477·7	137·0	557	535·4	153·5
318	305·7	87·6	378	363·3	104·2	438	421·0	120·7	498	478·7	137·3	558	536·4	153·8
319	306·6	87·9	379	364·3	104·4	439	422·0	121·0	499	479·7	137·5	559	537·4	154·1
320	307·6	88·2	380	365·3	104·7	440	422·9	121·2	500	480·6	137·8	560	538·3	154·4
321	308·5	88·4	381	366·2	105·0	441	423·9	121·5	501	481·6	138·1	561	539·3	154·7
322	309·5	88·7	382	367·2	105·3	442	424·9	121·8	502	482·6	138·3	562	540·3	154·9
323	310·5	89·0	383	368·1	105·5	443	425·8	122·1	503	483·5	138·6	563	541·2	155·2
324	311·4	89·3	384	369·1	105·8	444	426·8	122·3	504	484·5	138·9	564	542·2	155·4
325	312·4	89·5	385	370·1	106·1	445	427·7	122·6	505	485·4	139·2	565	543·1	155·7
326	313·3	89·8	386	371·0	106·4	446	428·7	122·9	506	486·4	139·4	566	544·1	156·0
327	314·3	90·1	387	372·0	106·6	447	429·7	123·2	507	487·3	139·7	567	545·1	156·3
328	315·3	90·4	388	372·9	106·9	448	430·6	123·4	508	488·3	140·0	568	546·0	156·6
329	316·2	90·6	389	373·9	107·2	449	431·6	123·7	509	489·3	140·3	569	547·0	156·9
330	317·2	90·9	390	374·9	107·5	450	432·6	124·0	510	490·2	140·6	570	547·9	157·1
331	318·2	91·2	391	375·8	107·7	451	433·5	124·3	511	491·2	140·8	571	548·9	157·3
332	319·1	91·5	392	376·8	108·0	452	434·5	124·6	512	492·1	141·1	572	549·8	157·6
333	320·1	91·8	393	377·8	108·3	453	435·4	124·8	513	493·1	141·4	573	550·8	157·9
334	321·0	92·0	394	378·7	108·6	454	436·4	125·1	514	494·1	141·7	574	551·8	158·2
335	322·0	92·3	395	379·7	108·8	455	437·4	125·4	515	495·0	141·9	575	552·7	158·4
336	323·0	92·6	396	380·6	109·1	456	438·3	125·7	516	496·0	142·2	576	553·7	158·7
337	323·9	92·9	397	381·6	109·4	457	439·3	125·9	517	496·9	142·5	577	554·6	159·0
338	324·9	93·1	398	382·6	109·7	458	440·2	126·2	518	497·9	142·8	578	555·6	159·3
339	325·8	93·4	399	383·5	109·9	459	441·2	126·5	519	498·9	143·0	579	556·5	159·5
340	326·8	93·7	400	384·5	110·2	460	442·2	126·8	520	499·8	143·3	580	557·5	159·8
341	327·8	94·0	401	385·4	110·5	461	443·1	127·0	521	500·8	143·6	581	558·4	160·1
342	328·7	94·2	402	386·4	110·8	462	444·1	127·3	522	501·7	143·9	582	559·4	160·4
343	329·7	94·5	403	387·4	111·0	463	445·0	127·6	523	502·7	144·1	583	560·4	160·6
344	330·7	94·8	404	388·3	111·3	464	446·0	127·9	524	503·7	144·4	584	561·3	161·0
345	331·6	95·1	405	389·3	111·6	465	447·0	128·1	525	504·6	144·7	585	562·3	161·3
346	332·6	95·3	406	390·2	111·9	466	447·9	128·4	526	505·6	145·0	586	563·2	161·6
347	333·5	95·6	407	391·2	112·1	467	448·9	128·7	527	506·6	145·3	587	564·2	161·8
348	334·5	95·9	408	392·2	112·4	468	449·8	129·0	528	507·5	145·6	588	565·2	162·1
349	335·5	96·2	409	393·1	112·7	469	450·8	129·2	529	508·5	145·8	589	566·1	162·4
350	336·4	96·4	410	394·1	113·0	470	451·8	129·5	530	509·4	146·1	590	567·1	162·7
351	337·4	96·7	411	395·1	113·3	471	452·7	129·8	531	510·4	146·4	591	568·1	162·9
352	338·3	97·0	412	396·0	113·5	472	453·7	130·1	532	511·4	146·7	592	569·0	163·2
353	339·3	97·3	413	397·0	113·8	473	454·7	130·3	533	512·3	146·9	593	570·0	163·5
354	340·3	97·5	414	397·9	114·1	474	455·6	130·6	534	513·3	147·2	594	571·0	163·8
355	341·2	97·8	415	398·9	114·4	475	456·6	130·9	535	514·3	147·5	595	571·9	164·0
356	342·2	98·1	416	399·9	114·6	476	457·5	131·2	536	515·2	147·8	596	572·9	164·3
357	343·1	98·4	417	400·8	114·9	477	458·5	131·4	537	516·2	148·0	597	573·9	164·6
358	344·1	98·6	418	401·8	115·2	478	459·5	131·7	538	517·2	148·2	598	574·8	164·9
359	345·1	98·9	419	402·7	115·5	479	460·4	132·0	539	518·1	148·5	599	575·8	165·1
360	346·0	99·2	420	403·7	115·8	480	461·4	132·3	540	519·1	148·8	600	576·8	165·4
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

74° 4ʰ 56ᵐ

TRAVERSE TABLE TO DEGREES

17° 1h 8m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	1·0	0·3	61	58·3	17·8	121	115·7	35·4	181	173·1	52·9	241	230·5	70·5
2	1·9	0·6	62	59·3	18·1	122	116·7	35·7	182	174·0	53·2	242	231·4	70·8
3	2·9	0·9	63	60·2	18·4	123	117·6	36·0	183	175·0	53·5	243	232·4	71·0
4	3·8	1·2	64	61·2	18·7	124	118·6	36·3	184	176·0	53·8	244	233·3	71·3
5	4·8	1·5	65	62·2	19·0	125	119·5	36·5	185	176·9	54·1	245	234·3	71·6
6	5·7	1·8	66	63·1	19·3	126	120·5	36·8	186	177·9	54·4	246	235·3	71·9
7	6·7	2·0	67	64·1	19·6	127	121·5	37·1	187	178·8	54·7	247	236·2	72·2
8	7·7	2·3	68	65·0	19·9	128	122·4	37·4	188	179·8	55·0	248	237·2	72·5
9	8·6	2·6	69	66·0	20·2	129	123·4	37·7	189	180·7	55·3	249	238·1	72·8
10	9·6	2·9	70	66·9	20·5	130	124·3	38·0	190	181·7	55·6	250	239·1	73·1
11	10·5	3·2	71	67·9	20·8	131	125·3	38·3	191	182·7	55·8	251	240·0	73·4
12	11·5	3·5	72	68·9	21·1	132	126·2	38·6	192	183·6	56·1	252	241·0	73·7
13	12·4	3·8	73	69·8	21·3	133	127·2	38·9	193	184·6	56·4	253	241·9	74·0
14	13·4	4·1	74	70·8	21·6	134	128·1	39·2	194	185·5	56·7	254	242·9	74·3
15	14·3	4·4	75	71·7	21·9	135	129·1	39·5	195	186·5	57·0	255	243·9	74·6
16	15·3	4·7	76	72·7	22·2	136	130·1	39·8	196	187·4	57·3	256	244·8	74·8
17	16·3	5·0	77	73·6	22·5	137	131·0	40·1	197	188·4	57·6	257	245·8	75·1
18	17·2	5·3	78	74·6	22·8	138	132·0	40·3	198	189·3	57·9	258	246·7	75·4
19	18·2	5·6	79	75·5	23·1	139	132·9	40·6	199	190·3	58·2	259	247·7	75·7
20	19·1	5·8	80	76·5	23·4	140	133·9	40·9	200	191·3	58·5	260	248·6	76·0
21	20·1	6·1	81	77·5	23·7	141	134·8	41·2	201	192·2	58·8	261	249·6	76·3
22	21·0	6·4	82	78·4	24·0	142	135·8	41·5	202	193·2	59·1	262	250·6	76·6
23	22·0	6·7	83	79·4	24·3	143	136·8	41·8	203	194·1	59·4	263	251·5	76·9
24	23·0	7·0	84	80·3	24·6	144	137·7	42·1	204	195·1	59·6	264	252·5	77·2
25	23·9	7·3	85	81·3	24·9	145	138·7	42·4	205	196·0	59·9	265	253·4	77·5
26	24·9	7·6	86	82·2	25·1	146	139·6	42·7	206	197·0	60·2	266	254·4	77·8
27	25·8	7·9	87	83·2	25·4	147	140·6	43·0	207	198·0	60·5	267	255·3	78·1
28	26·8	8·2	88	84·2	25·7	148	141·5	43·3	208	198·9	60·8	268	256·3	78·4
29	27·7	8·5	89	85·1	26·0	149	142·5	43·6	209	199·9	61·1	269	257·2	78·6
30	28·7	8·8	90	86·1	26·3	150	143·4	43·9	210	200·8	61·4	270	258·2	78·9
31	29·6	9·1	91	87·0	26·6	151	144·4	44·1	211	201·8	61·7	271	259·2	79·2
32	30·6	9·4	92	88·0	26·9	152	145·4	44·4	212	202·7	62·0	272	260·1	79·5
33	31·6	9·6	93	88·9	27·2	153	146·3	44·7	213	203·7	62·3	273	261·1	79·8
34	32·5	9·9	94	89·9	27·5	154	147·3	45·0	214	204·6	62·6	274	262·0	80·1
35	33·5	10·2	95	90·8	27·8	155	148·2	45·3	215	205·6	62·9	275	263·0	80·4
36	34·4	10·5	96	91·8	28·1	156	149·2	45·6	216	206·6	63·2	276	263·9	80·7
37	35·4	10·8	97	92·8	28·4	157	150·1	45·9	217	207·5	63·4	277	264·9	81·0
38	36·3	11·1	98	93·7	28·7	158	151·1	46·2	218	208·5	63·7	278	265·9	81·3
39	37·3	11·4	99	94·7	28·9	159	152·1	46·5	219	209·4	64·0	279	266·8	81·6
40	38·3	11·7	100	95·6	29·2	160	153·0	46·8	220	210·4	64·3	280	267·8	81·9
41	39·2	12·0	101	96·6	29·5	161	154·0	47·1	221	211·3	64·6	281	268·7	82·2
42	40·2	12·3	102	97·5	29·8	162	154·9	47·4	222	212·3	64·9	282	269·7	82·4
43	41·1	12·6	103	98·5	30·1	163	155·9	47·7	223	213·3	65·2	283	270·6	82·7
44	42·1	12·9	104	99·5	30·4	164	156·8	47·9	224	214·2	65·5	284	271·6	83·0
45	43·0	13·2	105	100·4	30·7	165	157·8	48·2	225	215·2	65·8	285	272·5	83·3
46	44·0	13·4	106	101·4	31·0	166	158·7	48·5	226	216·1	66·1	286	273·5	83·6
47	44·9	13·7	107	102·3	31·3	167	159·7	48·8	227	217·1	66·4	287	274·5	83·9
48	45·9	14·0	108	103·3	31·6	168	160·7	49·1	228	218·0	66·7	288	275·4	84·2
49	46·9	14·3	109	104·2	31·9	169	161·6	49·4	229	219·0	67·0	289	276·4	84·5
50	47·8	14·6	110	105·2	32·2	170	162·6	49·7	230	220·0	67·2	290	277·3	84·8
51	48·8	14·9	111	106·1	32·5	171	163·5	50·0	231	220·9	67·5	291	278·3	85·1
52	49·7	15·2	112	107·1	32·7	172	164·5	50·3	232	221·9	67·8	292	279·2	85·4
53	50·7	15·5	113	108·1	33·0	173	165·4	50·6	233	222·8	68·1	293	280·2	85·7
54	51·6	15·8	114	109·0	33·3	174	166·4	50·9	234	223·8	68·4	294	281·2	86·0
55	52·6	16·1	115	110·0	33·6	175	167·4	51·2	235	224·7	68·7	295	282·1	86·2
56	53·6	16·4	116	110·9	33·9	176	168·3	51·5	236	225·7	69·0	296	283·1	86·5
57	54·5	16·7	117	111·9	34·2	177	169·3	51·7	237	226·6	69·3	297	284·0	86·8
58	55·5	17·0	118	112·8	34·5	178	170·2	52·0	238	227·6	69·6	298	285·0	87·1
59	56·4	17·2	119	113·8	34·8	179	171·2	52·3	239	228·6	69·9	299	285·9	87·4
60	57·4	17·5	120	114·8	35·1	180	172·1	52·6	240	229·5	70·2	300	286·9	87·7
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

73° 4h 52m

TRAVERSE TABLE TO DEGREES

17° $1^h\ 8^m$

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	287.8	88.0	361	345.2	105.5	421	402.6	123.1	481	460.0	140.6	541	517.3	158.2
302	288.8	88.3	362	346.1	105.8	422	403.5	123.4	482	460.9	140.9	542	518.3	158.5
303	289.7	88.6	363	347.1	106.1	423	404.5	123.7	483	461.9	141.2	543	519.2	158.8
304	290.7	88.9	364	348.1	106.4	424	405.4	124.0	484	462.8	141.5	544	520.2	159.1
305	291.6	89.2	365	349.0	106.7	425	406.4	124.3	485	463.8	141.8	545	521.2	159.3
306	292.6	89.5	366	350.0	107.0	426	407.3	124.6	486	464.7	142.1	546	522.1	159.6
307	293.5	89.8	367	350.9	107.3	427	408.3	124.8	487	465.7	142.3	547	523.1	159.9
308	294.5	90.1	368	351.9	107.6	428	409.3	125.1	488	466.7	142.6	548	524.0	160.2
309	295.5	90.3	369	352.8	107.9	429	410.2	125.4	489	467.6	142.9	549	525.0	160.5
310	296.4	90.6	370	353.8	108.2	430	411.2	125.7	490	468.6	143.2	550	526.0	160.8
311	297.4	90.9	371	354.8	108.5	431	412.1	126.0	491	469.5	143.5	551	526.9	161.1
312	298.3	91.2	372	355.7	108.8	432	413.1	126.3	492	470.5	143.8	552	527.9	161.4
313	299.3	91.5	373	356.7	109.1	433	414.0	126.6	493	471.4	144.1	553	528.8	161.7
314	300.2	91.8	374	357.6	109.4	434	415.0	126.9	494	472.4	144.4	554	529.8	162.0
315	301.2	92.1	375	358.6	109.6	435	416.0	127.2	495	473.4	144.7	555	530.8	162.3
316	302.2	92.4	376	359.5	109.9	436	416.9	127.5	496	474.3	145.0	556	531.7	162.6
317	303.1	92.7	377	360.5	110.2	437	417.9	127.8	497	475.3	145.3	557	532.7	162.9
318	304.1	93.0	378	361.4	110.5	438	418.8	128.1	498	476.2	145.6	558	533.6	163.2
319	305.0	93.3	379	362.4	110.8	439	419.8	128.4	499	477.2	145.9	559	534.6	163.5
320	306.0	93.6	380	363.4	111.1	440	420.7	128.6	500	478.1	146.2	560	535.5	163.8
321	306.9	93.9	381	364.3	111.4	441	421.7	128.9	501	479.1	146.5	561	536.5	164.1
322	307.9	94.1	382	365.3	111.7	442	422.7	129.2	502	480.1	146.8	562	537.5	164.4
323	308.8	94.4	383	366.2	112.0	443	423.6	129.5	503	481.0	147.1	563	538.4	164.6
324	309.8	94.7	384	367.2	112.3	444	424.6	129.8	504	482.0	147.4	564	539.4	164.8
325	310.8	95.0	385	368.1	112.6	445	425.5	130.1	505	482.9	147.7	565	540.3	165.1
326	311.7	95.3	386	369.1	112.9	446	426.5	130.4	506	483.9	148.0	566	541.3	165.4
327	312.7	95.6	387	370.1	113.2	447	427.4	130.7	507	484.8	148.3	567	542.2	165.7
328	313.6	95.9	388	371.0	113.4	448	428.4	131.0	508	485.8	148.6	568	543.2	166.0
329	314.6	96.2	389	372.0	113.7	449	429.3	131.3	509	486.7	148.9	569	544.1	166.4
330	315.5	96.5	390	372.9	114.0	450	430.3	131.6	510	487.7	149.1	570	545.1	166.7
331	316.5	96.8	391	373.9	114.3	451	431.3	131.9	511	488.7	149.4	571	546.1	167.0
332	317.5	97.1	392	374.8	114.6	452	432.2	132.2	512	489.6	149.7	572	547.0	167.2
333	318.4	97.4	393	375.8	114.9	453	433.2	132.4	513	490.6	150.0	573	548.0	167.5
334	319.4	97.7	394	376.7	115.2	454	434.1	132.7	514	491.5	150.2	574	548.9	167.8
335	320.3	97.9	395	377.7	115.5	455	435.1	133.0	515	492.5	150.5	575	549.9	168.1
336	321.3	98.2	396	378.7	115.8	456	436.0	133.3	516	493.4	150.8	576	550.8	168.4
337	322.2	98.5	397	379.6	116.1	457	437.0	133.6	517	494.4	151.1	577	551.8	168.7
338	323.2	98.8	398	380.6	116.4	458	438.0	133.9	518	495.3	151.4	578	552.7	169.0
339	324.2	99.1	399	381.5	116.7	459	438.9	134.2	519	496.3	151.7	579	553.7	169.3
340	325.1	99.4	400	382.5	117.0	460	439.9	134.5	520	497.2	152.0	580	554.6	169.6
341	326.1	99.7	401	383.4	117.2	461	440.8	134.8	521	498.2	152.3	581	555.6	169.9
342	327.0	100.0	402	384.4	117.5	462	441.8	135.1	522	499.2	152.6	582	556.5	170.2
343	328.0	100.3	403	385.4	117.8	463	442.7	135.4	523	500.1	152.9	583	557.5	170.5
344	328.9	100.6	404	386.3	118.1	464	443.7	135.7	524	501.1	153.2	584	558.4	170.8
345	329.9	100.9	405	387.3	118.4	465	444.6	136.0	525	502.0	153.5	585	559.4	171.1
346	330.8	101.2	406	388.2	118.7	466	445.6	136.2	526	503.0	153.8	586	560.4	171.3
347	331.8	101.5	407	389.2	119.0	467	446.6	136.5	527	503.9	154.1	587	561.3	171.6
348	332.8	101.8	408	390.1	119.3	468	447.5	136.8	528	504.9	154.4	588	562.3	171.9
349	333.7	102.0	409	391.1	119.6	469	448.5	137.1	529	505.9	154.7	589	563.2	172.2
350	334.7	102.3	410	392.0	119.9	470	449.4	137.4	530	506.8	155.0	590	564.2	172.5
351	335.6	102.6	411	393.0	120.2	471	450.4	137.7	531	507.8	155.3	591	565.1	172.8
352	336.6	102.9	412	394.0	120.5	472	451.3	138.0	532	508.7	155.5	592	566.1	173.1
353	337.5	103.2	413	394.9	120.8	473	452.3	138.3	533	509.7	155.9	593	567.1	173.4
354	338.5	103.5	414	395.9	121.0	474	453.3	138.6	534	510.6	156.2	594	568.0	173.7
355	339.5	103.8	415	396.8	121.3	475	454.2	138.9	535	511.6	156.5	595	569.0	174.0
356	340.4	104.1	416	397.8	121.6	476	455.2	139.2	536	512.6	156.8	596	569.9	174.3
357	341.4	104.4	417	398.7	121.9	477	456.1	139.5	537	513.5	157.1	597	570.9	174.6
358	342.3	104.7	418	399.7	122.2	478	457.1	139.8	538	514.5	157.3	598	571.8	174.9
359	343.3	105.0	419	400.7	122.5	479	458.0	140.0	539	515.4	157.6	599	572.8	175.2
360	344.2	105.3	420	401.6	122.8	480	459.0	140.3	540	516.4	157.9	600	573.8	175.4
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

73° $4^h\ 52^m$

TRAVERSE TABLE TO DEGREES

18° — 1h 12m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	1·0	0·3	61	58·0	18·9	121	115·1	37·4	181	172·1	55·9	241	229·2	74·5
2	1·9	0·6	62	59·0	19·2	122	116·0	37·7	182	173·1	56·2	242	230·2	74·8
3	2·9	0·9	63	59·9	19·5	123	117·0	38·0	183	174·0	56·6	243	231·1	75·1
4	3·8	1·2	64	60·9	19·8	124	117·9	38·3	184	175·0	56·9	244	232·1	75·4
5	4·8	1·5	65	61·8	20·1	125	118·9	38·6	185	175·9	57·2	245	233·0	75·7
6	5·7	1·9	66	62·8	20·4	126	119·8	38·9	186	176·9	57·5	246	234·0	76·0
7	6·7	2·2	67	63·7	20·7	127	120·8	39·2	187	177·8	57·8	247	234·9	76·3
8	7·6	2·5	68	64·7	21·0	128	121·7	39·6	188	178·8	58·1	248	235·9	76·6
9	8·6	2·8	69	65·6	21·3	129	122·7	39·9	189	179·7	58·4	249	236·8	76·9
10	9·5	3·1	70	66·6	21·6	130	123·6	40·2	190	180·7	58·7	250	237·8	77·3
11	10·5	3·4	71	67·5	21·9	131	124·6	40·5	191	181·7	59·0	251	238·7	77·6
12	11·4	3·7	72	68·5	22·2	132	125·5	40·8	192	182·6	59·3	252	239·7	77·9
13	12·4	4·0	73	69·4	22·6	133	126·5	41·1	193	183·6	59·6	253	240·6	78·2
14	13·3	4·3	74	70·4	22·9	134	127·4	41·4	194	184·5	59·9	254	241·6	78·5
15	14·3	4·6	75	71·3	23·2	135	128·4	41·7	195	185·5	60·3	255	242·5	78·8
16	15·2	4·9	76	72·3	23·5	136	129·3	42·0	196	186·4	60·6	256	243·5	79·1
17	16·2	5·3	77	73·2	23·8	137	130·3	42·3	197	187·4	60·9	257	244·4	79·4
18	17·1	5·6	78	74·2	24·1	138	131·2	42·6	198	188·3	61·2	258	245·4	79·7
19	18·1	5·9	79	75·1	24·4	139	132·2	43·0	199	189·3	61·5	259	246·3	80·0
20	19·0	6·2	80	76·1	24·7	140	133·1	43·3	200	190·2	61·8	260	247·3	80·3
21	20·0	6·5	81	77·0	25·0	141	134·1	43·6	201	191·2	62·1	261	248·2	80·7
22	20·9	6·8	82	78·0	25·3	142	135·1	43·9	202	192·1	62·4	262	249·2	81·0
23	21·9	7·1	83	78·9	25·6	143	136·0	44·2	203	193·1	62·7	263	250·1	81·3
24	22·8	7·4	84	79·9	26·0	144	137·0	44·5	204	194·0	63·0	264	251·1	81·6
25	23·8	7·7	85	80·8	26·3	145	137·9	44·8	205	195·0	63·3	265	252·0	81·9
26	24·7	8·0	86	81·8	26·6	146	138·9	45·1	206	195·9	63·7	266	253·0	82·2
27	25·7	8·3	87	82·7	26·9	147	139·8	45·4	207	196·9	64·0	267	253·9	82·5
28	26·6	8·7	88	83·7	27·2	148	140·8	45·7	208	197·8	64·3	268	254·9	82·8
29	27·6	9·0	89	84·6	27·5	149	141·7	46·0	209	198·8	64·6	269	255·8	83·1
30	28·5	9·3	90	85·6	27·8	150	142·7	46·4	210	199·7	64·9	270	256·8	83·4
31	29·5	9·6	91	86·5	28·1	151	143·6	46·7	211	200·7	65·2	271	257·7	83·7
32	30·4	9·9	92	87·5	28·4	152	144·6	47·0	212	201·6	65·5	272	258·7	84·1
33	31·4	10·2	93	88·4	28·7	153	145·5	47·3	213	202·6	65·8	273	259·6	84·4
34	32·3	10·5	94	89·4	29·0	154	146·5	47·6	214	203·5	66·1	274	260·6	84·7
35	33·3	10·8	95	90·4	29·4	155	147·4	47·9	215	204·5	66·4	275	261·5	85·0
36	34·2	11·1	96	91·3	29·7	156	148·4	48·2	216	205·4	66·7	276	262·5	85·3
37	35·2	11·4	97	92·3	30·0	157	149·3	48·5	217	206·4	67·1	277	263·4	85·6
38	36·1	11·7	98	93·2	30·3	158	150·3	48·8	218	207·3	67·4	278	264·4	85·9
39	37·1	12·1	99	94·2	30·6	159	151·2	49·1	219	208·3	67·7	279	265·3	86·2
40	38·0	12·4	100	95·1	30·9	160	152·2	49·4	220	209·2	68·0	280	266·3	86·5
41	39·0	12·7	101	96·1	31·2	161	153·1	49·8	221	210·2	68·3	281	267·2	86·8
42	39·9	13·0	102	97·0	31·5	162	154·1	50·1	222	211·1	68·6	282	268·2	87·1
43	40·9	13·3	103	98·0	31·8	163	155·0	50·4	223	212·1	68·9	283	269·1	87·5
44	41·8	13·6	104	98·9	32·1	164	156·0	50·7	224	213·0	69·2	284	270·1	87·8
45	42·8	13·9	105	99·9	32·4	165	156·9	51·0	225	214·0	69·5	285	271·1	88·1
46	43·7	14·2	106	100·8	32·8	166	157·9	51·3	226	214·9	69·8	286	272·0	88·4
47	44·7	14·5	107	101·8	33·1	167	158·8	51·6	227	215·9	70·1	287	273·0	88·7
48	45·7	14·8	108	102·7	33·4	168	159·8	51·9	228	216·8	70·5	288	273·9	89·0
49	46·6	15·1	109	103·7	33·7	169	160·7	52·2	229	217·8	70·8	289	274·9	89·3
50	47·6	15·5	110	104·6	34·0	170	161·7	52·5	230	218·7	71·1	290	275·8	89·6
51	48·5	15·8	111	105·6	34·3	171	162·6	52·8	231	219·7	71·4	291	276·8	89·9
52	49·5	16·1	112	106·5	34·6	172	163·6	53·2	232	220·6	71·7	292	277·7	90·2
53	50·4	16·4	113	107·5	34·9	173	164·5	53·5	233	221·6	72·0	293	278·7	90·5
54	51·4	16·7	114	108·4	35·2	174	165·5	53·8	234	222·5	72·3	294	279·6	90·9
55	52·3	17·0	115	109·4	35·5	175	166·4	54·1	235	223·5	72·6	295	280·6	91·2
56	53·3	17·3	116	110·3	35·8	176	167·4	54·4	236	224·4	72·9	296	281·5	91·5
57	54·2	17·6	117	111·3	36·2	177	168·3	54·7	237	225·4	73·2	297	282·5	91·8
58	55·2	17·9	118	112·2	36·5	178	169·3	55·0	238	226·4	73·5	298	283·4	92·1
59	56·1	18·2	119	113·2	36·8	179	170·2	55·3	239	227·3	73·9	299	284·4	92·4
60	57·1	18·5	120	114·1	37·1	180	171·2	55·6	240	228·3	74·2	300	285·3	92·7
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

72° — 4h 48m

TRAVERSE TABLE TO DEGREES

18° 1h 12m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	286·3	93·0	361	343·3	111·6	421	400·4	130·1	481	457·5	148·6	541	514·5	167·2
302	287·2	93·3	362	344·3	111·9	422	401·4	130·4	482	458·5	148·9	542	515·5	167·5
303	288·2	93·7	363	345·2	112·2	423	402·3	130·7	483	459·4	149·3	543	516·4	167·9
304	289·1	94·0	364	346·2	112·5	424	403·3	131·0	484	460·4	149·6	544	517·4	168·2
305	290·1	94·3	365	347·1	112·8	425	404·2	131·3	485	461·3	149·9	545	518·3	168·5
306	291·0	94·6	366	348·1	113·1	426	405·2	131·7	486	462·3	150·2	546	519·3	168·8
307	292·0	94·9	367	349·0	113·4	427	406·1	132·0	487	463·2	150·5	547	520·2	169·1
308	292·9	95·2	368	350·0	113·7	428	407·1	132·3	488	464·2	150·8	548	521·2	169·4
309	293·9	95·5	369	350·9	114·0	429	408·0	132·6	489	465·1	151·1	549	522·1	169·7
310	294·8	95·8	370	351·9	114·3	430	409·0	132·9	490	466·1	151·4	550	523·1	170·0
311	295·8	96·1	371	352·9	114·7	431	409·9	133·2	491	467·0	151·7	551	524·0	170·3
312	296·7	96·4	372	353·8	115·0	432	410·9	133·5	492	468·0	152·0	552	525·0	170·6
313	297·7	96·7	373	354·8	115·3	433	411·8	133·8	493	468·9	152·3	553	525·9	170·9
314	298·6	97·0	374	355·7	115·6	434	412·8	134·1	494	469·8	152·6	554	526·9	171·2
315	299·6	97·4	375	356·7	115·9	435	413·7	134·4	495	470·8	153·0	555	527·8	171·5
316	300·5	97·7	376	357·6	116·2	436	414·7	134·7	496	471·7	153·3	556	528·8	171·8
317	301·5	98·0	377	358·6	116·5	437	415·6	135·1	497	472·7	153·6	557	529·7	172·1
318	302·4	98·3	378	359·5	116·8	438	416·6	135·4	498	473·6	153·9	558	530·7	172·4
319	303·4	98·6	379	360·5	117·1	439	417·5	135·7	499	474·6	154·2	559	531·6	172·7
320	304·3	98·9	380	361·4	117·4	440	418·5	136·0	500	475·5	154·5	560	532·6	173·0
321	305·3	99·2	381	362·4	117·7	441	419·4	136·3	501	476·5	154·8	561	533·5	173·3
322	306·2	99·5	382	363·3	118·1	442	420·4	136·6	502	477·4	155·1	562	534·5	173·6
323	307·2	99·8	383	364·3	118·4	443	421·3	136·9	503	478·4	155·4	563	535·4	173·9
324	308·2	100·1	384	365·2	118·7	444	422·3	137·2	504	479·3	155·7	564	536·4	174·2
325	309·1	100·4	385	366·2	119·0	445	423·2	137·5	505	480·3	156·1	565	537·3	174·6
326	310·1	100·7	386	367·1	119·3	446	424·2	137·8	506	481·2	156·4	566	538·3	174·9
327	311·0	101·1	387	368·1	119·6	447	425·1	138·1	507	482·2	156·7	567	539·2	175·2
328	312·0	101·4	388	369·0	119·9	448	426·1	138·4	508	483·2	157·0	568	540·2	175·5
329	312·9	101·7	389	370·0	120·2	449	427·0	138·8	509	484·1	157·3	569	541·1	175·8
330	313·9	102·0	390	370·9	120·5	450	428·0	139·1	510	485·1	157·6	570	542·1	176·1
331	314·8	102·3	391	371·9	120·8	451	428·9	139·4	511	486·0	157·9	571	543·0	176·4
332	315·8	102·6	392	372·8	121·1	452	429·9	139·7	512	487·0	158·2	572	544·0	176·7
333	316·7	102·9	393	373·8	121·5	453	430·8	140·0	513	487·9	158·5	573	544·9	177·0
334	317·7	103·2	394	374·7	121·8	454	431·8	140·3	514	488·9	158·8	574	545·9	177·3
335	318·6	103·5	395	375·7	122·1	455	432·7	140·6	515	489·8	159·1	575	546·8	177·6
336	319·6	103·8	396	376·6	122·4	456	433·7	140·9	516	490·8	159·4	576	547·8	178·0
337	320·5	104·1	397	377·6	122·7	457	434·6	141·2	517	491·7	159·7	577	548·7	178·3
338	321·5	104·5	398	378·5	123·0	458	435·6	141·5	518	492·7	160·0	578	549·7	178·6
339	322·4	104·8	399	379·5	123·3	459	436·5	141·8	519	493·6	160·3	579	550·6	178·9
340	323·4	105·1	400	380·4	123·6	460	437·5	142·2	520	494·6	160·7	580	551·6	179·2
341	324·3	105·4	401	381·4	123·9	461	438·4	142·5	521	495·5	161·0	581	552·5	179·5
342	325·3	105·7	402	382·3	124·2	462	439·4	142·8	522	496·5	161·3	582	553·5	179·8
343	326·2	106·0	403	383·3	124·5	463	440·3	143·1	523	497·4	161·6	583	554·4	180·1
344	327·2	106·3	404	384·2	124·9	464	441·3	143·4	524	498·4	161·9	584	555·4	180·4
345	328·1	106·6	405	385·2	125·2	465	442·2	143·7	525	499·3	162·2	585	556·3	180·7
346	329·1	106·9	406	386·1	125·5	466	443·2	144·0	526	500·3	162·5	586	557·3	181·1
347	330·0	107·2	407	387·1	125·8	467	444·2	144·3	527	501·2	162·9	587	558·2	181·4
348	331·0	107·5	408	388·0	126·1	468	445·1	144·6	528	502·2	163·2	588	559·2	181·7
349	331·9	107·9	409	389·0	126·4	469	446·1	144·9	529	503·1	163·5	589	560·1	182·0
350	332·9	108·2	410	389·9	126·7	470	447·0	145·2	530	504·1	163·8	590	561·1	182·3
351	333·8	108·5	411	390·9	127·0	471	448·0	145·6	531	505·0	164·1	591	562·0	182·7
352	334·8	108·8	412	391·8	127·3	472	448·9	145·9	532	506·0	164·4	592	563·0	183·0
353	335·7	109·1	413	392·8	127·6	473	449·9	146·2	533	506·9	164·7	593	563·9	183·3
354	336·7	109·4	414	393·7	127·9	474	450·8	146·5	534	507·9	165·0	594	564·9	183·6
355	337·6	109·7	415	394·7	128·3	475	451·8	146·8	535	508·8	165·3	595	565·8	183·9
356	338·6	110·0	416	395·6	128·6	476	452·7	147·1	536	509·8	165·6	596	566·8	184·2
357	339·5	110·3	417	396·6	128·9	477	453·7	147·4	537	510·7	165·9	597	567·7	184·5
358	340·5	110·6	418	397·5	129·2	478	454·6	147·7	538	511·7	166·2	598	568·7	184·8
359	341·4	110·9	419	398·5	129·5	479	455·6	148·0	539	512·6	166·5	599	569·6	185·1
360	342·4	111·3	420	399·5	129·8	480	456·5	148·3	540	513·6	166·9	600	570·6	185·4
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

72° 4h 48m

TRAVERSE TABLE TO DEGREES

19° 1h 16m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0.9	0.3	61	57.7	19.9	121	114.4	39.4	181	171.1	58.9	241	227.9	78.5
2	1.9	0.7	62	58.6	20.2	122	115.4	39.7	182	172.1	59.3	242	228.8	78.8
3	2.8	1.0	63	59.6	20.5	123	116.3	40.0	183	173.0	59.6	243	229.8	79.1
4	3.8	1.3	64	60.5	20.8	124	117.2	40.4	184	174.0	59.9	244	230.7	79.4
5	4.7	1.6	65	61.5	21.2	125	118.2	40.7	185	174.9	60.2	245	231.7	79.8
6	5.7	2.0	66	62.4	21.5	126	119.1	41.0	186	175.9	60.6	246	232.6	80.1
7	6.6	2.3	67	63.3	21.8	127	120.1	41.3	187	176.8	60.9	247	233.5	80.4
8	7.6	2.6	68	64.3	22.1	128	121.0	41.7	188	177.8	61.2	248	234.5	80.7
9	8.5	2.9	69	65.2	22.5	129	122.0	42.0	189	178.7	61.5	249	235.4	81.1
10	9.5	3.3	70	66.2	22.8	130	122.9	42.3	190	179.6	61.9	250	236.4	81.4
11	10.4	3.6	71	67.1	23.1	131	123.9	42.6	191	180.6	62.2	251	237.3	81.7
12	11.3	3.9	72	68.1	23.4	132	124.8	43.0	192	181.5	62.5	252	238.3	82.0
13	12.3	4.2	73	69.0	23.8	133	125.8	43.3	193	182.5	62.8	253	239.2	82.4
14	13.2	4.6	74	70.0	24.1	134	126.7	43.6	194	183.4	63.2	254	240.2	82.7
15	14.2	4.9	75	70.9	24.4	135	127.6	44.0	195	184.4	63.5	255	241.1	83.0
16	15.1	5.2	76	71.9	24.7	136	128.6	44.3	196	185.3	63.8	256	242.1	83.3
17	16.1	5.5	77	72.8	25.1	137	129.5	44.6	197	186.3	64.1	257	243.0	83.7
18	17.0	5.9	78	73.8	25.4	138	130.5	44.9	198	187.2	64.5	258	243.9	84.0
19	18.0	6.2	79	74.7	25.7	139	131.4	45.3	199	188.2	64.8	259	244.9	84.3
20	18.9	6.5	80	75.6	26.0	140	132.4	45.6	200	189.1	65.1	260	245.8	84.6
21	19.9	6.8	81	76.6	26.4	141	133.3	45.9	201	190.0	65.4	261	246.8	85.0
22	20.8	7.2	82	77.5	26.7	142	134.3	46.2	202	191.0	65.8	262	247.7	85.3
23	21.7	7.5	83	78.5	27.0	143	135.2	46.6	203	191.9	66.1	263	248.7	85.6
24	22.7	7.8	84	79.4	27.3	144	136.2	46.9	204	192.9	66.4	264	249.6	86.0
25	23.6	8.1	85	80.4	27.7	145	137.1	47.2	205	193.8	66.7	265	250.6	86.3
26	24.6	8.5	86	81.3	28.0	146	138.0	47.5	206	194.8	67.1	266	251.5	86.6
27	25.5	8.8	87	82.3	28.3	147	139.0	47.9	207	195.7	67.4	267	252.5	86.9
28	26.5	9.1	88	83.2	28.6	148	139.9	48.2	208	196.7	67.7	268	253.4	87.3
29	27.4	9.4	89	84.2	29.0	149	140.9	48.5	209	197.6	68.0	269	254.3	87.6
30	28.4	9.8	90	85.1	29.3	150	141.8	48.8	210	198.6	68.4	270	255.3	87.9
31	29.3	10.1	91	86.0	29.6	151	142.8	49.2	211	199.5	68.7	271	256.2	88.2
32	30.3	10.4	92	87.0	30.0	152	143.7	49.5	212	200.4	69.0	272	257.2	88.6
33	31.2	10.7	93	87.9	30.3	153	144.7	49.8	213	201.4	69.3	273	258.1	88.9
34	32.1	11.1	94	88.9	30.6	154	145.6	50.1	214	202.3	69.7	274	259.1	89.2
35	33.1	11.4	95	89.8	30.9	155	146.6	50.5	215	203.3	70.0	275	260.0	89.5
36	34.0	11.7	96	90.8	31.3	156	147.5	50.8	216	204.2	70.3	276	261.0	89.9
37	35.0	12.0	97	91.7	31.6	157	148.4	51.1	217	205.2	70.6	277	261.9	90.2
38	35.9	12.4	98	92.7	31.9	158	149.4	51.4	218	206.1	71.0	278	262.9	90.5
39	36.9	12.7	99	93.6	32.2	159	150.3	51.8	219	207.1	71.3	279	263.8	90.8
40	37.8	13.0	100	94.6	32.6	160	151.3	52.1	220	208.0	71.6	280	264.7	91.2
41	38.8	13.3	101	95.5	32.9	161	152.2	52.4	221	209.0	72.0	281	265.7	91.5
42	39.7	13.7	102	96.4	33.2	162	153.2	52.7	222	209.9	72.3	282	266.6	91.8
43	40.7	14.0	103	97.4	33.5	163	154.1	53.1	223	210.9	72.6	283	267.6	92.1
44	41.6	14.3	104	98.3	33.9	164	155.1	53.4	224	211.8	72.9	284	268.5	92.5
45	42.5	14.7	105	99.3	34.2	165	156.0	53.7	225	212.7	73.3	285	269.5	92.8
46	43.5	15.0	106	100.2	34.5	166	157.0	54.0	226	213.7	73.6	286	270.4	93.1
47	44.4	15.3	107	101.2	34.8	167	157.9	54.4	227	214.6	73.9	287	271.4	93.4
48	45.4	15.6	108	102.1	35.2	168	158.8	54.7	228	215.6	74.2	288	272.3	93.8
49	46.3	16.0	109	103.1	35.5	169	159.8	55.0	229	216.5	74.6	289	273.3	94.1
50	47.3	16.3	110	104.0	35.8	170	160.7	55.3	230	217.5	74.9	290	274.2	94.4
51	48.2	16.6	111	105.0	36.1	171	161.7	55.7	231	218.4	75.2	291	275.1	94.7
52	49.2	16.9	112	105.9	36.5	172	162.6	56.0	232	219.4	75.5	292	276.1	95.1
53	50.1	17.3	113	106.8	36.8	173	163.6	56.3	233	220.3	75.9	293	277.0	95.4
54	51.1	17.6	114	107.8	37.1	174	164.5	56.6	234	221.3	76.2	294	278.0	95.7
55	52.0	17.9	115	108.7	37.4	175	165.5	57.0	235	222.2	76.5	295	278.9	96.0
56	52.9	18.2	116	109.7	37.8	176	166.4	57.3	236	223.1	76.8	296	279.9	96.4
57	53.9	18.6	117	110.6	38.1	177	167.4	57.6	237	224.1	77.2	297	280.8	96.7
58	54.8	18.9	118	111.6	38.4	178	168.3	58.0	238	225.0	77.5	298	281.8	97.0
59	55.8	19.2	119	112.5	38.7	179	169.2	58.3	239	226.0	77.8	299	282.7	97.3
60	56.7	19.5	120	113.5	39.1	180	170.2	58.6	240	226.9	78.1	300	283.7	97.7
Dist.	Dep.	D.Lat.	Dist.	Dep.	D.Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

71° 4h 44m

TRAVERSE TABLE TO DEGREES

19° — $1^h\ 16^m$

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	284·6	98·0	361	341·3	117·5	421	398·1	137·0	481	454·8	156·6	541	511·5	176·1
302	285·5	98·3	362	342·3	117·8	422	399·0	137·4	482	455·7	156·9	542	512·4	176·4
303	286·5	98·6	363	343·2	118·2	423	400·0	137·7	483	456·7	157·2	543	513·4	176·8
304	287·4	99·0	364	344·2	118·5	424	400·9	138·0	484	457·6	157·6	544	514·3	177·1
305	288·4	99·3	365	345·1	118·8	425	401·8	138·4	485	458·6	157·9	545	515·3	177·4
306	289·3	99·6	366	346·1	119·1	426	402·8	138·7	486	459·5	158·2	546	516·2	177·7
307	290·3	99·9	367	347·0	119·5	427	403·7	139·0	487	460·5	158·5	547	517·2	178·1
308	291·2	100·3	368	348·0	119·8	428	404·7	139·3	488	461·4	158·9	548	518·1	178·4
309	292·2	100·6	369	348·9	120·1	429	405·6	139·7	489	462·4	159·2	549	519·1	178·7
310	293·1	100·9	370	349·8	120·4	430	406·6	140·0	490	463·3	159·5	550	520·0	179·0
311	294·1	101·2	371	350·8	120·8	431	407·5	140·3	491	464·3	159·8	551	521·0	179·4
312	295·0	101·6	372	351·7	121·1	432	408·5	140·6	492	465·2	160·2	552	521·9	179·7
313	295·9	101·9	373	352·7	121·4	433	409·4	141·0	493	466·1	160·5	553	522·8	180·0
314	296·9	102·2	374	353·6	121·7	434	410·4	141·3	494	467·1	160·8	554	523·8	180·3
315	297·8	102·5	375	354·6	122·1	435	411·3	141·6	495	468·0	161·1	555	524·7	180·7
316	298·8	102·9	376	355·5	122·4	436	412·2	141·9	496	469·0	161·5	556	525·7	181·0
317	299·7	103·2	377	356·5	122·7	437	413·2	142·3	497	469·9	161·8	557	526·6	181·3
318	300·7	103·5	378	357·4	123·0	438	414·1	142·6	498	470·9	162·1	558	527·6	181·6
319	301·6	103·8	379	358·4	123·4	439	415·1	142·9	499	471·8	162·4	559	528·5	182·0
320	302·6	104·2	380	359·3	123·7	440	416·0	143·2	500	472·8	162·8	560	529·5	182·3
321	303·5	104·5	381	360·2	124·0	441	417·0	143·6	501	473·7	163·1	561	530·4	182·6
322	304·5	104·8	382	361·2	124·4	442	417·9	143·9	502	474·7	163·4	562	531·4	182·9
323	305·4	105·1	383	362·1	124·7	443	418·9	144·2	503	475·6	163·7	563	532·3	183·3
324	306·3	105·5	384	363·1	125·0	444	419·8	144·5	504	476·5	164·1	564	533·2	183·6
325	307·3	105·8	385	364·0	125·3	445	420·8	144·9	505	477·5	164·4	565	534·2	183·9
326	308·2	106·1	386	365·0	125·7	446	421·7	145·2	506	478·4	164·7	566	535·1	184·2
327	309·2	106·4	387	365·9	126·0	447	422·6	145·5	507	479·4	165·0	567	536·1	184·6
328	310·1	106·8	388	366·9	126·3	448	423·6	145·8	508	480·3	165·4	568	537·0	184·9
329	311·1	107·1	389	367·8	126·6	449	424·5	146·2	509	481·2	165·7	569	538·0	185·2
330	312·0	107·4	390	368·8	127·0	450	425·5	146·5	510	482·2	166·1	570	538·9	185·6
331	313·0	107·7	391	369·7	127·3	451	426·4	146·8	511	483·1	166·4	571	539·9	185·9
332	313·9	108·1	392	370·6	127·6	452	427·4	147·1	512	484·1	166·7	572	540·8	186·2
333	314·9	108·4	393	371·6	127·9	453	428·3	147·5	513	485·0	167·0	573	541·7	186·5
334	315·8	108·7	394	372·5	128·3	454	429·3	147·8	514	486·0	167·4	574	542·7	186·9
335	316·7	109·1	395	373·5	128·6	455	430·2	148·1	515	486·9	167·7	575	543·6	187·2
336	317·7	109·4	396	374·4	128·9	456	431·2	148·4	516	487·9	168·0	576	544·6	187·5
337	318·6	109·7	397	375·4	129·2	457	432·1	148·8	517	488·8	168·3	577	545·5	187·8
338	319·6	110·0	398	376·3	129·6	458	433·0	149·1	518	489·7	168·7	578	546·5	188·2
339	320·5	110·4	399	377·3	129·9	459	434·0	149·4	519	490·7	169·0	579	547·4	188·5
340	321·5	110·7	400	378·2	130·2	460	434·9	149·7	520	491·6	169·3	580	548·4	188·8
341	322·4	111·0	401	379·2	130·5	461	435·9	150·1	521	492·6	169·6	581	549·3	189·1
342	323·4	111·3	402	380·1	130·9	462	436·8	150·4	522	493·5	170·0	582	550·3	189·5
343	324·3	111·7	403	381·0	131·2	463	437·8	150·7	523	494·5	170·3	583	551·2	189·8
344	325·3	112·0	404	382·0	131·5	464	438·7	151·0	524	495·4	170·6	584	552·2	190·1
345	326·2	112·3	405	382·9	131·8	465	439·7	151·4	525	496·4	170·9	585	553·1	190·4
346	327·1	112·6	406	383·9	132·2	466	440·6	151·7	526	497·3	171·2	586	554·1	190·8
347	328·1	113·0	407	384·8	132·5	467	441·6	152·0	527	498·3	171·6	587	555·0	191·1
348	329·0	113·3	408	385·8	132·8	468	442·5	152·4	528	499·2	171·9	588	555·9	191·4
349	330·0	113·6	409	386·7	133·1	469	443·4	152·7	529	500·1	172·2	589	556·9	191·7
350	330·9	113·9	410	387·7	133·5	470	444·4	153·0	530	501·1	172·5	590	557·8	192·1
351	331·9	114·3	411	388·6	133·8	471	445·3	153·3	531	502·0	172·9	591	558·8	192·4
352	332·8	114·6	412	389·6	134·1	472	446·3	153·7	532	503·0	173·2	592	559·7	192·7
353	333·8	114·9	413	390·5	134·4	473	447·2	154·0	533	503·9	173·5	593	560·7	193·0
354	334·7	115·2	414	391·4	134·8	474	448·2	154·3	534	504·9	173·8	594	561·6	193·4
355	335·7	115·6	415	392·4	135·1	475	449·1	154·6	535	505·8	174·2	595	562·6	193·7
356	336·6	115·9	416	393·3	135·4	476	450·1	155·0	536	506·8	174·5	596	563·5	194·0
357	337·5	116·2	417	394·3	135·7	477	451·0	155·3	537	507·7	174·8	597	564·5	194·3
358	338·5	116·5	418	395·2	136·1	478	452·0	155·6	538	508·7	175·1	598	565·4	194·7
359	339·4	116·9	419	396·2	136·4	479	452·9	155·9	539	509·6	175·5	599	566·4	195·0
360	340·4	117·2	420	397·1	136·7	480	453·8	156·3	540	510·6	175·8	600	567·3	195·3
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat.

71° — $4^h\ 44^m$

TRAVERSE TABLE TO DEGREES

													20°	1h 20m
Dist.	D.Lat	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·9	0·3	61	57·3	20·9	121	113·7	41·4	181	170·1	61·9	241	226·5	82·4
2	1·9	0·7	62	58·3	21·2	122	114·6	41·7	182	171·0	62·2	242	227·4	82·8
3	2·8	1·0	63	59·2	21·5	123	115·6	42·1	183	172·0	62·6	243	228·3	83·1
4	3·8	1·4	64	60·1	21·9	124	116·5	42·4	184	172·9	62·9	244	229·3	83·5
5	4·7	1·7	65	61·1	22·2	125	117·5	42·8	185	173·8	63·3	245	230·2	83·8
6	5·6	2·1	66	62·0	22·6	126	118·4	43·1	186	174·8	63·6	246	231·2	84·1
7	6·6	2·4	67	63·0	22·9	127	119·3	43·4	187	175·7	64·0	247	232·1	84·5
8	7·5	2·7	68	63·9	23·3	128	120·3	43·8	188	176·7	64·3	248	233·0	84·8
9	8·5	3·1	69	64·8	23·6	129	121·2	44·1	189	177·6	64·6	249	234·0	85·2
10	9·4	3·4	70	65·8	23·9	130	122·2	44·5	190	178·5	65·0	250	234·9	85·5
11	10·3	3·8	71	66·7	24·3	131	123·1	44·8	191	179·5	65·3	251	235·9	85·8
12	11·3	4·1	72	67·7	24·6	132	124·0	45·1	192	180·4	65·7	252	236·8	86·2
13	12·2	4·4	73	68·6	25·0	133	125·0	45·5	193	181·4	66·0	253	237·7	86·5
14	13·2	4·8	74	69·5	25·3	134	125·9	45·8	194	182·3	66·4	254	238·7	86·9
15	14·1	5·1	75	70·5	25·7	135	126·9	46·2	195	183·2	66·7	255	239·6	87·2
16	15·0	5·5	76	71·4	26·0	136	127·8	46·5	196	184·2	67·0	256	240·6	87·6
17	16·0	5·8	77	72·4	26·3	137	128·7	46·9	197	185·1	67·4	257	241·5	87·9
18	16·9	6·2	78	73·3	26·7	138	129·7	47·2	198	186·1	67·7	258	242·4	88·2
19	17·9	6·5	79	74·2	27·0	139	130·6	47·5	199	187·0	68·1	259	243·4	88·6
20	18·8	6·8	80	75·2	27·4	140	131·6	47·9	200	187·9	68·4	260	244·3	88·9
21	19·7	7·2	81	76·1	27·7	141	132·5	48·2	201	188·9	68·7	261	245·3	89·3
22	20·7	7·5	82	77·1	28·0	142	133·4	48·6	202	189·8	69·1	262	246·2	89·6
23	21·6	7·9	83	78·0	28·4	143	134·4	48·9	203	190·8	69·4	263	247·1	90·0
24	22·6	8·2	84	78·9	28·7	144	135·3	49·3	204	191·7	69·8	264	248·1	90·3
25	23·5	8·6	85	79·9	29·1	145	136·3	49·6	205	192·6	70·1	265	249·0	90·6
26	24·4	8·9	86	80·8	29·4	146	137·2	49·9	206	193·6	70·5	266	250·0	91·0
27	25·4	9·2	87	81·8	29·8	147	138·1	50·3	207	194·5	70·8	267	250·9	91·3
28	26·3	9·6	88	82·7	30·1	148	139·1	50·6	208	195·5	71·1	268	251·8	91·7
29	27·3	9·9	89	83·6	30·4	149	140·0	51·0	209	196·4	71·5	269	252·8	92·0
30	28·2	10·3	90	84·6	30·8	150	141·0	51·3	210	197·3	71·8	270	253·7	92·3
31	29·1	10·6	91	85·5	31·1	151	141·9	51·6	211	198·3	72·2	271	254·7	92·7
32	30·1	10·9	92	86·5	31·5	152	142·8	52·0	212	199·2	72·5	272	255·6	93·0
33	31·0	11·3	93	87·4	31·8	153	143·8	52·3	213	200·2	72·9	273	256·5	93·4
34	31·9	11·6	94	88·3	32·1	154	144·7	52·7	214	201·1	73·2	274	257·5	93·7
35	32·9	12·0	95	89·3	32·5	155	145·7	53·0	215	202·0	73·5	275	258·4	94·1
36	33·8	12·3	96	90·2	32·8	156	146·6	53·4	216	203·0	73·9	276	259·4	94·4
37	34·8	12·7	97	91·2	33·2	157	147·5	53·7	217	203·9	74·2	277	260·3	94·7
38	35·7	13·0	98	92·1	33·5	158	148·5	54·0	218	204·9	74·6	278	261·2	95·1
39	36·6	13·3	99	93·0	33·9	159	149·4	54·4	219	205·8	74·9	279	262·2	95·4
40	37·6	13·7	100	94·0	34·2	160	150·4	54·7	220	206·7	75·2	280	263·1	95·8
41	38·5	14·0	101	94·9	34·5	161	151·3	55·1	221	207·7	75·6	281	264·1	96·1
42	39·5	14·4	102	95·8	34·9	162	152·2	55·4	222	208·6	75·9	282	265·0	96·4
43	40·4	14·7	103	96·8	35·2	163	153·2	55·7	223	209·6	76·3	283	265·9	96·8
44	41·3	15·0	104	97·7	35·6	164	154·1	56·1	224	210·5	76·6	284	266·9	97·1
45	42·3	15·4	105	98·7	35·9	165	155·0	56·4	225	211·4	77·0	285	267·8	97·5
46	43·2	15·7	106	99·6	36·3	166	156·0	56·8	226	212·4	77·3	286	268·8	97·8
47	44·2	16·1	107	100·5	36·6	167	156·9	57·1	227	213·3	77·6	287	269·7	98·2
48	45·1	16·4	108	101·5	36·9	168	157·9	57·5	228	214·2	78·0	288	270·6	98·5
49	46·0	16·8	109	102·4	37·3	169	158·8	57·8	229	215·2	78·3	289	271·6	98·8
50	47·0	17·1	110	103·4	37·6	170	159·7	58·1	230	216·1	78·7	290	272·5	99·2
51	47·9	17·4	111	104·3	38·0	171	160·7	58·5	231	217·1	79·0	291	273·5	99·5
52	48·9	17·8	112	105·2	38·3	172	161·6	58·8	232	218·0	79·3	292	274·4	99·9
53	49·8	18·1	113	106·2	38·6	173	162·6	59·2	233	218·9	79·7	293	275·3	100·2
54	50·7	18·5	114	107·1	39·0	174	163·5	59·5	234	219·9	80·0	294	276·3	100·6
55	51·7	18·8	115	108·1	39·3	175	164·4	59·9	235	220·8	80·4	295	277·2	100·9
56	52·6	19·2	116	109·0	39·7	176	165·4	60·2	236	221·8	80·7	296	278·1	101·2
57	53·6	19·5	117	109·9	40·0	177	166·3	60·5	237	222·7	81·1	297	279·1	101·6
58	54·5	19·8	118	110·9	40·4	178	167·3	60·9	238	223·6	81·4	298	280·0	101·9
59	55·4	20·2	119	111·8	40·7	179	168·2	61·2	239	224·6	81·7	299	281·0	102·3
60	56·4	20·5	120	112·8	41·0	180	169·1	61·6	240	225·5	82·1	300	281·9	102·6
Dist.	Dep.	D.Lat	Dist.	Dep.	D.Lat	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.
													70°	4h 40m

TRAVERSE TABLE TO DEGREES

20° — 1h 20m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	282·9	103·0	361	339·2	123·5	421	395·6	144·0	481	452·0	164·5	541	508·4	185·0
302	283·8	103·3	362	340·2	123·8	422	396·6	144·3	482	453·0	164·8	542	509·3	185·4
303	284·7	103·6	363	341·1	124·2	423	397·5	144·7	483	453·9	165·2	543	510·3	185·7
304	285·7	104·0	364	342·1	124·5	424	398·4	145·0	484	454·8	165·5	544	511·2	186·0
305	286·6	104·3	365	343·0	124·8	425	399·4	145·4	485	455·8	165·9	545	512·1	186·4
306	287·6	104·7	366	343·9	125·2	426	400·3	145·7	486	456·7	166·3	546	513·1	186·8
307	288·5	105·0	367	344·9	125·5	427	401·3	146·1	487	457·7	166·6	547	514·0	187·1
308	289·4	105·4	368	345·8	125·9	428	402·2	146·4	488	458·6	166·9	548	515·0	187·4
309	290·4	105·7	369	346·8	126·2	429	403·1	146·7	489	459·5	167·3	549	515·9	187·8
310	291·3	106·0	370	347·7	126·6	430	404·1	147·1	490	460·5	167·7	550	516·8	188·2
311	292·3	106·4	371	348·6	126·9	431	405·0	147·4	491	461·4	168·0	551	517·8	188·5
312	293·2	106·7	372	349·6	127·2	432	406·0	147·8	492	462·4	168·3	552	518·7	188·8
313	294·1	107·1	373	350·5	127·6	433	406·9	148·1	493	463·3	168·6	553	519·7	189·1
314	295·1	107·4	374	351·5	127·9	434	407·8	148·4	494	464·2	168·9	554	520·6	189·4
315	296·0	107·7	375	352·4	128·3	435	408·8	148·8	495	465·2	169·3	555	521·5	189·8
316	297·0	108·1	376	353·3	128·6	436	409·7	149·1	496	466·1	169·6	556	522·5	190·2
317	297·9	108·4	377	354·3	129·0	437	410·7	149·5	497	467·0	170·0	557	523·4	190·5
318	298·8	108·8	378	355·2	129·3	438	411·6	149·8	498	468·0	170·3	558	524·4	190·8
319	299·8	109·1	379	356·2	129·6	439	412·5	150·2	499	468·9	170·7	559	525·3	191·2
320	300·7	109·5	380	357·1	130·0	440	413·5	150·5	500	469·9	171·0	560	526·2	191·6
321	301·6	109·8	381	358·0	130·3	441	414·4	150·8	501	470·8	171·3	561	527·2	191·9
322	302·6	110·1	382	359·0	130·7	442	415·4	151·2	502	471·7	171·7	562	528·1	192·2
323	303·5	110·5	383	359·9	131·0	443	416·3	151·5	503	472·7	172·0	563	529·0	192·5
324	304·5	110·8	384	360·8	131·3	444	417·2	151·9	504	473·6	172·4	564	530·0	192·9
325	305·4	111·2	385	361·8	131·7	445	418·2	152·2	505	474·5	172·7	565	530·9	193·2
326	306·3	111·5	386	362·7	132·0	446	419·1	152·5	506	475·4	173·0	566	531·8	193·6
327	307·3	111·8	387	363·7	132·4	447	420·0	152·9	507	476·4	173·4	567	532·8	193·9
328	308·2	112·2	388	364·6	132·7	448	421·0	153·2	508	477·3	173·7	568	533·7	194·2
329	309·2	112·5	389	365·5	133·1	449	421·9	153·6	509	478·3	174·1	569	534·7	194·6
330	310·1	112·9	390	366·5	133·4	450	422·9	153·9	510	479·2	174·4	570	535·6	195·0
331	311·0	113·2	391	367·4	133·7	451	423·8	154·3	511	480·2	174·8	571	536·6	195·3
332	312·0	113·6	392	368·4	134·1	452	424·7	154·6	512	481·1	175·1	572	537·5	195·6
333	312·9	113·9	393	369·3	134·4	453	425·7	154·9	513	482·1	175·4	573	538·5	195·9
334	313·9	114·2	394	370·2	134·8	454	426·6	155·3	514	483·0	175·8	574	539·4	196·3
335	314·8	114·6	395	371·2	135·1	455	427·6	155·6	515	484·0	176·1	575	540·3	196·6
336	315·7	114·9	396	372·1	135·4	456	428·5	156·0	516	484·9	176·5	576	541·3	197·0
337	316·7	115·3	397	373·1	135·8	457	429·4	156·3	517	485·8	176·8	577	542·2	197·3
338	317·6	115·6	398	374·0	136·1	458	430·4	156·7	518	486·8	177·2	578	543·2	197·7
339	318·6	116·0	399	374·9	136·5	459	431·3	157·0	519	487·7	177·5	579	544·1	198·0
340	319·5	116·3	400	375·9	136·8	460	432·3	157·4	520	488·7	177·9	580	545·0	198·4
341	320·4	116·6	401	376·8	137·2	461	433·2	157·7	521	489·6	178·2	581	546·0	198·7
342	321·4	117·0	402	377·8	137·5	462	434·1	158·0	522	490·5	178·5	582	546·9	199·0
343	322·3	117·3	403	378·7	137·8	463	435·1	158·4	523	491·5	178·9	583	547·9	199·4
344	323·3	117·7	404	379·6	138·2	464	436·0	158·7	524	492·4	179·2	584	548·8	199·8
345	324·2	118·0	405	380·6	138·5	465	437·0	159·0	525	493·4	179·6	585	549·8	200·1
346	325·1	118·4	406	381·5	138·9	466	437·9	159·4	526	494·3	179·9	586	550·7	200·4
347	326·1	118·7	407	382·5	139·2	467	438·8	159·7	527	495·3	180·2	587	551·7	200·8
348	327·0	119·0	408	383·4	139·6	468	439·8	160·1	528	496·2	180·6	588	552·6	201·2
349	328·0	119·4	409	384·3	139·9	469	440·7	160·4	529	497·1	181·0	589	553·5	201·5
350	328·9	119·7	410	385·3	140·2	470	441·7	160·8	530	498·1	181·3	590	554·4	201·8
351	329·8	120·1	411	386·2	140·6	471	442·6	161·1	531	499·0	181·6	591	555·4	202·1
352	330·8	120·4	412	387·2	140·9	472	443·5	161·4	532	499·9	181·9	592	556·3	202·4
353	331·7	120·7	413	388·1	141·3	473	444·5	161·8	533	500·9	182·3	593	557·3	202·8
354	332·7	121·1	414	389·0	141·6	474	445·4	162·1	534	501·8	182·6	594	558·2	203·2
355	333·6	121·4	415	390·0	141·9	475	446·4	162·5	535	502·7	183·0	595	559·1	203·5
356	334·5	121·8	416	390·9	142·3	476	447·3	162·8	536	503·7	183·3	596	560·0	203·8
357	335·5	122·1	417	391·9	142·6	477	448·2	163·2	537	504·6	183·7	597	561·0	204·2
358	336·4	122·5	418	392·8	143·0	478	449·2	163·5	538	505·5	184·0	598	561·9	204·6
359	337·4	122·8	419	393·7	143·3	479	450·1	163·8	539	506·5	184·3	599	562·9	204·9
360	338·3	123·1	420	394·7	143·7	480	451·1	164·2	540	507·4	184·7	600	563·8	205·2
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

70° — 4h 40m

TRAVERSE TABLE TO DEGREES

21° — 1h 24m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·9	0·4	61	56·9	21·9	121	113·0	43·4	181	169·0	64·9	241	225·0	86·4
2	1·9	0·7	62	57·9	22·2	122	113·9	43·7	182	169·9	65·2	242	225·9	86·7
3	2·8	1·1	63	58·8	22·6	123	114·8	44·1	183	170·8	65·6	243	226·9	87·1
4	3·7	1·4	64	59·7	22·9	124	115·8	44·4	184	171·8	65·9	244	227·8	87·4
5	4·7	1·8	65	60·7	23·3	125	116·7	44·8	185	172·7	66·3	245	228·7	87·8
6	5·6	2·2	66	61·6	23·7	126	117·6	45·2	186	173·6	66·7	246	229·7	88·2
7	6·5	2·5	67	62·5	24·0	127	118·6	45·5	187	174·6	67·0	247	230·6	88·5
8	7·5	2·9	68	63·5	24·4	128	119·5	45·9	188	175·5	67·4	248	231·5	88·9
9	8·4	3·2	69	64·4	24·7	129	120·4	46·2	189	176·4	67·7	249	232·5	89·2
10	9·3	3·6	70	65·4	25·1	130	121·4	46·6	190	177·4	68·1	250	233·4	89·6
11	10·3	3·9	71	66·3	25·4	131	122·3	46·9	191	178·3	68·4	251	234·3	90·0
12	11·2	4·3	72	67·2	25·8	132	123·2	47·3	192	179·2	68·8	252	235·3	90·3
13	12·1	4·7	73	68·2	26·2	133	124·2	47·7	193	180·2	69·2	253	236·2	90·7
14	13·1	5·0	74	69·1	26·5	134	125·1	48·0	194	181·1	69·5	254	237·1	91·0
15	14·0	5·4	75	70·0	26·9	135	126·0	48·4	195	182·0	69·9	255	238·1	91·4
16	14·9	5·7	76	71·0	27·2	136	127·0	48·7	196	183·0	70·2	256	239·0	91·7
17	15·9	6·1	77	71·9	27·6	137	127·9	49·1	197	183·9	70·6	257	239·9	92·1
18	16·8	6·5	78	72·8	28·0	138	128·8	49·5	198	184·8	71·0	258	240·9	92·5
19	17·7	6·8	79	73·8	28·3	139	129·8	49·8	199	185·8	71·3	259	241·8	92·8
20	18·7	7·2	80	74·7	28·7	140	130·7	50·2	200	186·7	71·7	260	242·7	93·2
21	19·6	7·5	81	75·6	29·0	141	131·6	50·5	201	187·6	72·0	261	243·7	93·5
22	20·5	7·9	82	76·6	29·4	142	132·6	50·9	202	188·6	72·4	262	244·6	93·9
23	21·5	8·2	83	77·5	29·7	143	133·5	51·2	203	189·5	72·7	263	245·5	94·3
24	22·4	8·6	84	78·4	30·1	144	134·4	51·6	204	190·5	73·1	264	246·5	94·6
25	23·3	9·0	85	79·4	30·5	145	135·4	52·0	205	191·4	73·5	265	247·4	95·0
26	24·3	9·3	86	80·3	30·8	146	136·3	52·3	206	192·3	73·8	266	248·3	95·3
27	25·2	9·7	87	81·2	31·2	147	137·2	52·7	207	193·3	74·2	267	249·3	95·7
28	26·1	10·0	88	82·2	31·5	148	138·2	53·0	208	194·2	74·5	268	250·2	96·0
29	27·1	10·4	89	83·1	31·9	149	139·1	53·4	209	195·1	74·9	269	251·1	96·4
30	28·0	10·8	90	84·0	32·3	150	140·0	53·8	210	196·1	75·3	270	252·1	96·8
31	28·9	11·1	91	85·0	32·6	151	141·0	54·1	211	197·0	75·6	271	253·0	97·1
32	29·9	11·5	92	85·9	33·0	152	141·9	54·5	212	197·9	76·0	272	253·9	97·5
33	30·8	11·8	93	86·8	33·3	153	142·8	54·8	213	198·9	76·3	273	254·9	97·8
34	31·7	12·2	94	87·8	33·7	154	143·8	55·2	214	199·8	76·7	274	255·8	98·2
35	32·7	12·5	95	88·7	34·0	155	144·7	55·5	215	200·7	77·0	275	256·7	98·6
36	33·6	12·9	96	89·6	34·4	156	145·6	55·9	216	201·7	77·4	276	257·7	98·9
37	34·5	13·3	97	90·6	34·8	157	146·6	56·3	217	202·6	77·8	277	258·6	99·3
38	35·5	13·6	98	91·5	35·1	158	147·5	56·6	218	203·5	78·1	278	259·5	99·6
39	36·4	14·0	99	92·4	35·5	159	148·4	57·0	219	204·5	78·5	279	260·5	100·0
40	37·3	14·3	100	93·4	35·8	160	149·4	57·3	220	205·4	78·8	280	261·4	100·3
41	38·3	14·7	101	94·3	36·2	161	150·3	57·7	221	206·3	79·2	281	262·3	100·7
42	39·2	15·1	102	95·2	36·6	162	151·2	58·1	222	207·3	79·6	282	263·3	101·1
43	40·1	15·4	103	96·2	36·9	163	152·2	58·4	223	208·2	79·9	283	264·2	101·4
44	41·1	15·8	104	97·1	37·3	164	153·1	58·8	224	209·1	80·3	284	265·1	101·8
45	42·0	16·1	105	98·0	37·6	165	154·0	59·1	225	210·1	80·6	285	266·1	102·1
46	42·9	16·5	106	99·0	38·0	166	155·0	59·5	226	211·0	81·0	286	267·0	102·5
47	43·9	16·8	107	99·9	38·3	167	155·9	59·8	227	211·9	81·3	287	267·9	102·9
48	44·8	17·2	108	100·8	38·7	168	156·8	60·2	228	212·9	81·7	288	268·9	103·2
49	45·7	17·6	109	101·8	39·1	169	157·8	60·6	229	213·8	82·1	289	269·8	103·6
50	46·7	17·9	110	102·7	39·4	170	158·7	60·9	230	214·7	82·4	290	270·7	103·9
51	47·6	18·3	111	103·6	39·8	171	159·6	61·3	231	215·7	82·8	291	271·7	104·3
52	48·5	18·6	112	104·6	40·1	172	160·6	61·6	232	216·6	83·1	292	272·6	104·6
53	49·5	19·0	113	105·5	40·5	173	161·5	62·0	233	217·5	83·5	293	273·5	105·0
54	50·4	19·4	114	106·4	40·9	174	162·4	62·4	234	218·5	83·9	294	274·5	105·4
55	51·3	19·7	115	107·4	41·2	175	163·4	62·7	235	219·4	84·2	295	275·4	105·7
56	52·3	20·1	116	108·3	41·6	176	164·3	63·1	236	220·3	84·6	296	276·3	106·1
57	53·2	20·4	117	109·2	41·9	177	165·2	63·4	237	221·3	84·9	297	277·3	106·4
58	54·1	20·8	118	110·2	42·3	178	166·2	63·8	238	222·2	85·3	298	278·2	106·8
59	55·1	21·1	119	111·1	42·6	179	167·1	64·1	239	223·1	85·6	299	279·1	107 2
60	56·0	21·5	120	112·0	43·0	180	168·0	64·5	240	224·1	86·0	300	280·1	107·5
Dist.	Dep.	D.Lat	Dist.	Dep.	D.Lat	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat

69° — 4h 36m

TRAVERSE TABLE TO DEGREES

21° 1h 24m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	281·0	107·9	361	337·0	129·4	421	393·0	150·9	481	449·0	172·4	541	505·1	193·9
302	281·9	108·2	362	337·9	129·7	422	394·0	151·2	482	450·0	172·7	542	506·0	194·2
303	282·9	108·6	363	338·9	130·1	423	394·9	151·6	483	450·9	173·1	543	507·0	194·6
304	283·8	108·9	364	339·8	130·4	424	395·8	152·0	484	451·8	173·5	544	507·9	195·0
305	284·7	109·3	365	340·7	130·8	425	396·8	152·3	485	452·8	173·8	545	508·8	195·3
306	285·7	109·7	366	341·7	131·2	426	397·7	152·7	486	453·7	174·2	546	509·8	195·7
307	286·6	110·0	367	342·6	131·5	427	398·6	153·0	487	454·6	174·5	547	510·7	196·0
308	287·5	110·4	368	343·5	131·9	428	399·6	153·4	488	455·6	174·9	548	511·6	196·4
309	288·5	110·7	369	344·5	132·2	429	400·5	153·7	489	456·5	175·2	549	512·6	196·8
310	289·4	111·1	370	345·4	132·6	430	401·4	154·1	490	457·4	175·6	550	513·5	197·1
311	290·3	111·5	371	346·3	133·0	431	402·4	154·5	491	458·4	176·0	551	514·4	197·5
312	291·3	111·8	372	347·3	133·3	432	403·3	154·8	492	459·3	176·3	552	515·4	197·8
313	292·2	112·2	373	348·2	133·7	433	404·2	155·2	493	460·2	176·7	553	516·3	198·2
314	293·1	112·5	374	349·1	134·0	434	405·2	155·5	494	461·2	177·0	554	517·2	198·6
315	294·1	112·9	375	350·1	134·4	435	406·1	155·9	495	462·1	177·4	555	518·2	198·9
316	295·0	113·2	376	351·0	134·7	436	407·0	156·3	496	463·0	177·8	556	519·1	199·3
317	295·9	113·6	377	351·9	135·1	437	408·0	156·6	497	464·0	178·1	557	520·0	199·6
318	296·9	114·0	378	352·9	135·5	438	408·9	157·0	498	464·9	178·5	558	521·0	200·0
319	297·8	114·3	379	353·8	135·8	439	409·8	157·3	499	465·8	178·8	559	521·9	200·3
320	298·7	114·7	380	354·7	136·2	440	410·8	157·7	500	466·8	179·2	560	522·8	200·7
321	299·7	115·0	381	355·7	136·5	441	411·7	158·0	501	467·7	179·5	561	523·8	201·0
322	300·6	115·4	382	356·6	136·9	442	412·6	158·4	502	468·6	179·9	562	524·7	201·4
323	301·5	115·8	383	357·5	137·3	443	413·6	158·8	503	469·6	180·3	563	525·6	201·8
324	302·5	116·1	384	358·5	137·6	444	414·5	159·1	504	470·5	180·6	564	526·6	202·1
325	303·4	116·5	385	359·4	138·0	445	415·4	159·5	505	471·5	181·0	565	527·5	202·5
326	304·3	116·8	386	360·3	138·3	446	416·4	159·8	506	472·4	181·3	566	528·4	202·8
327	305·3	117·2	387	361·3	138·7	447	417·3	160·2	507	473·3	181·7	567	529·4	203·2
328	306·2	117·5	388	362·2	139·1	448	418·2	160·5	508	474·3	182·0	568	530·3	203·5
329	307·1	117·9	389	363·1	139·4	449	419·2	160·9	509	475·2	182·4	569	531·2	203·9
330	308·1	118·3	390	364·1	139·8	450	420·1	161·3	510	476·1	182·8	570	532·2	204·3
331	309·0	118·6	391	365·0	140·1	451	421·0	161·6	511	477·1	183·1	571	533·1	204·6
332	309·9	119·0	392	365·9	140·5	452	422·0	162·0	512	478·0	183·5	572	534·0	205·0
333	310·9	119·3	393	366·9	140·8	453	422·9	162·3	513	478·9	183·8	573	535·0	205·4
334	311·8	119·7	394	367·8	141·2	454	423·8	162·7	514	479·9	184·2	574	535·9	205·7
335	312·7	120·1	395	368·7	141·6	455	424·8	163·1	515	480·8	184·6	575	536·8	206·1
336	313·7	120·4	396	369·7	141·9	456	425·7	163·4	516	481·7	184·9	576	537·8	206·4
337	314·6	120·8	397	370·6	142·3	457	426·6	163·8	517	482·7	185·3	577	538·7	206·8
338	315·5	121·1	398	371·5	142·6	458	427·6	164·1	518	483·6	185·6	578	539·6	207·1
339	316·5	121·5	399	372·5	143·0	459	428·5	164·5	519	484·5	186·0	579	540·6	207·5
340	317·4	121·8	400	373·4	143·4	460	429·4	164·9	520	485·5	186·4	580	541·5	207·9
341	318·3	122·2	401	374·3	143·7	461	430·4	165·2	521	486·4	186·7	581	542·4	208·2
342	319·3	122·6	402	375·3	144·1	462	431·3	165·6	522	487·3	187·1	582	543·4	208·6
343	320·2	122·9	403	376·2	144·4	463	432·2	165·9	523	488·3	187·4	583	544·3	208·9
344	321·1	123·2	404	377·1	144·8	464	433·2	166·3	524	489·2	187·8	584	545·2	209·3
345	322·1	123·6	405	378·1	145·1	465	434·1	166·6	525	490·1	188·1	585	546·2	209·6
346	323·0	124·0	406	379·0	145·5	466	435·0	167·0	526	491·1	188·5	586	547·1	210·0
347	323·9	124·4	407	379·9	145·9	467	436·0	167·4	527	492·0	188·9	587	548·0	210·4
348	324·9	124·7	408	380·9	146·2	468	436·9	167·7	528	492·9	189·2	588	549·0	210·7
349	325·8	125·1	409	381·8	146·6	469	437·8	168·1	529	493·9	189·6	589	549·9	211·1
350	326·7	125·4	410	382·7	146·9	470	438·8	168·4	530	494·8	189·9	590	550·8	211·4
351	327·7	125·8	411	383·7	147·3	471	439·7	168·8	531	495·7	190·3	591	551·8	211·8
352	328·6	126·1	412	384·6	147·7	472	440·6	169·2	532	496·7	190·7	592	552·7	212·2
353	329·5	126·5	413	385·5	148·0	473	441·6	169·5	533	497·6	191·0	593	553·6	212·5
354	330·5	126·9	414	386·5	148·4	474	442·5	169·9	534	498·5	191·4	594	554·6	212·9
355	331·4	127·2	415	387·4	148·7	475	443·4	170·2	535	499·5	191·7	595	555·5	213·2
356	332·3	127·6	416	388·4	149·1	476	444·4	170·6	536	500·4	192·1	596	556·4	213·6
357	333·3	127·9	417	389·3	149·4	477	445·3	170·9	537	501·3	192·4	597	557·4	213·9
358	334·2	128·3	418	390·2	149·8	478	446·2	171·3	538	502·3	192·8	598	558·2	214·3
359	335·1	128·7	419	391·2	150·2	479	447·2	171·7	539	503·2	193·2	599	559·2	214·7
360	336·1	129·0	420	392·1	150·5	480	448·1	172·0	540	504·1	193·5	600	560·1	215·0
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

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TRAVERSE TABLE TO DEGREES

22° — 1h 28m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·9	0·4	61	56·6	22·9	121	112·2	45·3	181	167·8	67·8	241	223·5	90·3
2	1·9	0·7	62	57·5	23·2	122	113·1	45·7	182	168·7	68·2	242	224·4	90·7
3	2·8	1·1	63	58·4	23·6	123	114·0	46·1	183	169·7	68·6	243	225·3	91·0
4	3·7	1·5	64	59·3	24·0	124	115·0	46·5	184	170·6	68·9	244	226·2	91·4
5	4·6	1·9	65	60·3	24·3	125	115·9	46·8	185	171·5	69·3	245	227·2	91·8
6	5·6	2·2	66	61·2	24·7	126	116·8	47·2	186	172·5	69·7	246	228·1	92·2
7	6·5	2·6	67	62·1	25·1	127	117·8	47·6	187	173·4	70·1	247	229·0	92·5
8	7·4	3·0	68	63·0	25·5	128	118·7	47·9	188	174·3	70·4	248	229·9	92·9
9	8·3	3·4	69	64·0	25·8	129	119·6	48·3	189	175·2	70·8	249	230·9	93·3
10	9·3	3·7	70	64·9	26·2	130	120·5	48·7	190	176·2	71·2	250	231·8	93·7
11	10·2	4·1	71	65·8	26·6	131	121·5	49·1	191	177·1	71·5	251	232·7	94·0
12	11·1	4·5	72	66·8	27·0	132	122·4	49·4	192	178·0	71·9	252	233·7	94·4
13	12·1	4·9	73	67·7	27·3	133	123·3	49·8	193	178·9	72·3	253	234·6	94·8
14	13·0	5·2	74	68·6	27·7	134	124·2	50·2	194	179·9	72·7	254	235·5	95·2
15	13·9	5·6	75	69·5	28·1	135	125·2	50·6	195	180·8	73·0	255	236·4	95·5
16	14·8	6·0	76	70·5	28·5	136	126·1	50·9	196	181·7	73·4	256	237·4	95·9
17	15·8	6·4	77	71·4	28·8	137	127·0	51·3	197	182·7	73·8	257	238·3	96·3
18	16·7	6·7	78	72·3	29·2	138	128·0	51·7	198	183·6	74·2	258	239·2	96·6
19	17·6	7·1	79	73·2	29·6	139	128·9	52·1	199	184·5	74·5	259	240·1	97·0
20	18·5	7·5	80	74·2	30·0	140	129·8	52·4	200	185·4	74·9	260	241·1	97·4
21	19·5	7·9	81	75·1	30·3	141	130·7	52·8	201	186·4	75·3	261	242·0	97·8
22	20·4	8·2	82	76·0	30·7	142	131·7	53·2	202	187·3	75·7	262	242·9	98·1
23	21·3	8·6	83	77·0	31·1	143	132·6	53·6	203	188·2	76·0	263	243·8	98·5
24	22·3	9·0	84	77·9	31·5	144	133·5	53·9	204	189·1	76·4	264	244·8	98·9
25	23·2	9·4	85	78·8	31·8	145	134·4	54·3	205	190·1	76·8	265	245·7	99·3
26	24·1	9·7	86	79·7	32·2	146	135·4	54·7	206	191·0	77·2	266	246·6	99·6
27	25·0	10·1	87	80·7	32·6	147	136·3	55·1	207	191·9	77·5	267	247·6	100·0
28	26·0	10·5	88	81·6	33·0	148	137·2	55·4	208	192·9	77·9	268	248·5	100·4
29	26·9	10·9	89	82·5	33·3	149	138·2	55·8	209	193·8	78·3	269	249·4	100·8
30	27·8	11·2	90	83·4	33·7	150	139·1	56·2	210	194·7	78·7	270	250·3	101·1
31	28·7	11·6	91	84·4	34·1	151	140·0	56·6	211	195·6	79·0	271	251·3	101·5
32	29·7	12·0	92	85·3	34·5	152	140·9	56·9	212	196·6	79·4	272	252·2	101·9
33	30·6	12·4	93	86·2	34·8	153	141·9	57·3	213	197·5	79·8	273	253·1	102·3
34	31·5	12·7	94	87·2	35·2	154	142·8	57·7	214	198·4	80·2	274	254·0	102·6
35	32·5	13·1	95	88·1	35·6	155	143·7	58·1	215	199·3	80·5	275	255·0	103·0
36	33·4	13·5	96	89·0	36·0	156	144·6	58·4	216	200·3	80·9	276	255·9	103·4
37	34·3	13·9	97	89·9	36·3	157	145·6	58·8	217	201·2	81·3	277	256·8	103·8
38	35·2	14·2	98	90·9	36·7	158	146·5	59·2	218	202·1	81·7	278	257·8	104·1
39	36·2	14·6	99	91·8	37·1	159	147·4	59·6	219	203·1	82·0	279	258·7	104·5
40	37·1	15·0	100	92·7	37·5	160	148·3	59·9	220	204·0	82·4	280	259·6	104·9
41	38·0	15·4	101	93·6	37·8	161	149·3	60·3	221	204·9	82·8	281	260·5	105·3
42	38·9	15·7	102	94·6	38·2	162	150·2	60·7	222	205·8	83·2	282	261·5	105·6
43	39·9	16·1	103	95·5	38·6	163	151·1	61·1	223	206·8	83·5	283	262·4	106·0
44	40·8	16·5	104	96·4	39·0	164	152·1	61·4	224	207·7	83·9	284	263·3	106·4
45	41·7	16·9	105	97·4	39·3	165	153·0	61·8	225	208·6	84·3	285	264·2	106·8
46	42·7	17·2	106	98·3	39·7	166	153·9	62·2	226	209·5	84·7	286	265·2	107·1
47	43·6	17·6	107	99·2	40·1	167	154·8	62·6	227	210·5	85·0	287	266·1	107·5
48	44·5	18·0	108	100·1	40·5	168	155·8	62·9	228	211·4	85·4	288	267·0	107·9
49	45·4	18·4	109	101·1	40·8	169	156·7	63·3	229	212·3	85·8	289	268·0	108·3
50	46·4	18·7	110	102·0	41·2	170	157·6	63·7	230	213·3	86·2	290	268·9	108·6
51	47·3	19·1	111	102·9	41·6	171	158·5	64·1	231	214·2	86·5	291	269·8	109·0
52	48·2	19·5	112	103·8	42·0	172	159·5	64·4	232	215·1	86·9	292	270·7	109·4
53	49·1	19·9	113	104·8	42·3	173	160·4	64·8	233	216·0	87·3	293	271·7	109·8
54	50·1	20·2	114	105·7	42·7	174	161·3	65·2	234	217·0	87·7	294	272·6	110·1
55	51·0	20·6	115	106·6	43·1	175	162·3	65·6	235	217·9	88·0	295	273·5	110·5
56	51·9	21·0	116	107·6	43·5	176	163·2	65·9	236	218·8	88·4	296	274·4	110·9
57	52·8	21·4	117	108·5	43·8	177	164·1	66·3	237	219·7	88·8	297	275·4	111·3
58	53·8	21·7	118	109·4	44·2	178	165·0	66·7	238	220·7	89·2	298	276·3	111·6
59	54·7	22·1	119	110·3	44·6	179	166·0	67·1	239	221·6	89·5	299	277·2	112·0
60	55·6	22·5	120	111·3	45·0	180	166·9	67·4	240	222·5	89·9	300	278·2	112·4
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

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TRAVERSE TABLE TO DEGREES

22° 1h 28m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	279·1	112·7	361	334·7	135·2	421	390·3	157·7	481	446·0	180·2	541	501·6	202·7
302	280·0	113·1	362	335·6	135·6	422	391·3	158·1	482	446·9	180·6	542	502·5	203·1
303	280·9	113·5	363	336·6	136·0	423	392·2	158·4	483	447·8	180·9	543	503·4	203·5
304	281·9	113·9	364	337·5	136·3	424	393·1	158·8	484	448·8	181·3	544	504·4	203·8
305	282·8	114·2	365	338·4	136·7	425	394·1	159·2	485	449·7	181·7	545	505·3	204·2
306	283·7	114·6	366	339·3	137·1	426	395·0	159·6	486	450·6	182·1	546	506·2	204·6
307	284·6	115·0	367	340·3	137·5	427	395·9	159·9	487	451·6	182·4	547	507·2	205·0
308	285·6	115·4	368	341·2	137·8	428	396·8	160·3	488	452·5	182·8	548	508·1	205·3
309	286·5	115·7	369	342·1	138·2	429	397·8	160·7	489	453·4	183·2	549	509·0	205·7
310	287·4	116·1	370	343·1	138·6	430	398·7	161·1	490	454·3	183·6	550	510·0	206·1
311	288·4	116·5	371	344·0	139·0	431	399·6	161·4	491	455·3	184·0	551	510·9	206·5
312	289·3	116·8	372	344·9	139·3	432	400·5	161·8	492	456·2	184·3	552	511·8	206·8
313	290·2	117·2	373	345·8	139·7	433	401·5	162·2	493	457·1	184·7	553	512·7	207·2
314	291·1	117·6	374	346·8	140·1	434	402·4	162·6	494	458·0	185·1	554	513·6	207·6
315	292·1	118·0	375	347·7	140·5	435	403·3	162·9	495	459·0	185·4	555	514·6	208·0
316	293·0	118·3	376	348·6	140·8	436	404·3	163·3	496	459·9	185·8	556	515·5	208·3
317	293·9	118·7	377	349·5	141·2	437	405·2	163·7	497	460·8	186·2	557	516·4	208·7
318	294·8	119·1	378	350·5	141·6	438	406·1	164·1	498	461·8	186·6	558	517·4	209·1
319	295·8	119·5	379	351·4	141·9	439	407·0	164·4	499	462·7	186·9	559	518·3	209·4
320	296·7	119·8	380	352·3	142·3	440	408·0	164·8	500	463·6	187·3	560	519·2	209·8
321	297·6	120·2	381	353·3	142·7	441	408·9	165·2	501	464·5	187·7	561	520·1	210·2
322	298·6	120·6	382	354·2	143·1	442	409·8	165·5	502	465·4	188·0	562	521·0	210·5
323	299·5	121·0	383	355·1	143·4	443	410·7	165·9	503	466·4	188·4	563	522·0	210·9
324	300·4	121·3	384	356·0	143·8	444	411·7	166·3	504	467·3	188·8	564	522·9	211·3
325	301·3	121·7	385	357·0	144·2	445	412·6	166·7	505	468·2	189·2	565	523·8	211·7
326	302·3	122·1	386	357·9	144·6	446	413·5	167·0	506	469·2	189·5	566	524·8	212·0
327	303·2	122·5	387	358·8	144·9	447	414·5	167·4	507	470·1	189·9	567	525·7	212·4
328	304·1	122·8	388	359·7	145·3	448	415·4	167·8	508	471·0	190·3	568	526·6	212·8
329	305·0	123·2	389	360·7	145·7	449	416·3	168·2	509	471·9	190·7	569	527·5	213·2
330	306·0	123·6	390	361·6	146·1	450	417·2	168·5	510	472·9	191·1	570	528·5	213·5
331	306·9	124·0	391	362·5	146·4	451	418·2	168·9	511	473·8	191·4	571	529·4	213·9
332	307·8	124·3	392	363·5	146·8	452	419·1	169·3	512	474·7	191·8	572	530·3	214·3
333	308·8	124·7	393	364·4	147·2	453	420·0	169·7	513	475·6	192·2	573	531·2	214·7
334	309·7	125·1	394	365·3	147·6	454	420·9	170·0	514	476·6	192·5	574	532·2	215·0
335	310·6	125·5	395	366·2	147·9	455	421·9	170·4	515	477·5	192·9	575	533·1	215·4
336	311·5	125·8	396	367·2	148·3	456	422·8	170·8	516	478·4	193·3	576	534·0	215·8
337	312·5	126·2	397	368·1	148·7	457	423·7	171·2	517	479·3	193·7	577	534·9	216·2
338	313·4	126·6	398	369·0	149·1	458	424·6	171·5	518	480·3	194·0	578	535·9	216·5
339	314·3	127·0	399	369·9	149·4	459	425·6	171·9	519	481·2	194·4	579	536·8	216·9
340	315·2	127·3	400	370·9	149·8	460	426·5	172·3	520	482·1	194·8	580	537·7	217·3
341	316·2	127·7	401	371·8	150·2	461	427·4	172·7	521	483·0	195·2	581	538·6	217·7
342	317·1	128·1	402	372·7	150·6	462	428·4	173·0	522	484·0	195·5	582	539·6	218·0
343	318·0	128·5	403	373·7	150·9	463	429·3	173·4	523	484·9	195·9	583	540·5	218·4
344	319·0	128·8	404	374·6	151·3	464	430·2	173·8	524	485·8	196·3	584	541·4	218·8
345	319·9	129·2	405	375·5	151·7	465	431·1	174·2	525	486·7	196·7	585	542·4	219·2
346	320·8	129·6	406	376·4	152·1	466	432·1	174·5	526	487·7	197·0	586	543·3	219·5
347	321·7	130·0	407	377·4	152·4	467	433·0	174·9	527	488·6	197·4	587	544·2	219·9
348	322·7	130·3	408	378·3	152·8	468	433·9	175·3	528	489·5	197·8	588	545·1	220·3
349	323·6	130·7	409	379·2	153·2	469	434·8	175·7	529	490·4	198·2	589	546·1	220·7
350	324·5	131·1	410	380·1	153·6	470	435·8	176·0	530	491·4	198·5	590	547·0	221·0
351	325·4	131·5	411	381·1	153·9	471	436·7	176·4	531	492·3	198·9	591	547·9	221·4
352	326·4	131·8	412	382·0	154·3	472	437·6	176·8	532	493·2	199·3	592	548·9	221·8
353	327·3	132·2	413	382·9	154·7	473	438·6	177·2	533	494·2	199·7	593	549·8	222·2
354	328·2	132·6	414	383·9	155·1	474	439·5	177·5	534	495·1	200·0	594	550·7	222·5
355	329·2	133·0	415	384·8	155·4	475	440·4	177·9	535	496·0	200·4	595	551·7	222·9
356	330·1	133·3	416	385·7	155·8	476	441·3	178·3	536	496·9	200·8	596	552·6	223·3
357	331·0	133·7	417	386·6	156·2	477	442·3	178·7	537	497·9	201·2	597	553·5	223·7
358	332·0	134·1	418	387·6	156·6	478	443·2	179·0	538	498·8	201·5	598	554·4	224·0
359	332·9	134·5	419	388·5	156·9	479	444·1	179·4	539	499·7	201·9	599	555·4	224·4
360	333·8	134·8	420	389·4	157·3	480	445·0	179·8	540	500·7	202·3	600	556·3	224·8
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

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TRAVERSE TABLE TO DEGREES

23° 1h 32m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·9	0·4	61	56·2	23·8	121	111·4	47·3	181	166·6	70·7	241	221·8	94·2
2	1·8	0·8	62	57·1	24·2	122	112·3	47·7	182	167·5	71·1	242	222·8	94·6
3	2·8	1·2	63	58·0	24·6	123	113·2	48·1	183	168·5	71·5	243	223·7	94·9
4	3·7	1·6	64	58·9	25·0	124	114·1	48·5	184	169·4	71·9	244	224·6	95·3
5	4·6	2·0	65	59·8	25·4	125	115·1	48·8	185	170·3	72·3	245	225·5	95·7
6	5·5	2·3	66	60·8	25·8	126	116·0	49·2	186	171·2	72·7	246	226·4	96·1
7	6·4	2·7	67	61·7	26·2	127	116·9	49·6	187	172·1	73·1	247	227·4	96·5
8	7·4	3·1	68	62·6	26·6	128	117·8	50·0	188	173·1	73·5	248	228·3	96·9
9	8·3	3·5	69	63·5	27·0	129	118·7	50·4	189	174·0	73·8	249	229·2	97·3
10	9·2	3·9	70	64·4	27·4	130	119·7	50·8	190	174·9	74·2	250	230·1	97·7
11	10·1	4·3	71	65·4	27·7	131	120·6	51·2	191	175·8	74·6	251	231·0	98·1
12	11·0	4·7	72	66·3	28·1	132	121·5	51·6	192	176·7	75·0	252	232·0	98·5
13	12·0	5·1	73	67·2	28·5	133	122·4	52·0	193	177·7	75·4	253	232·9	98·9
14	12·9	5·5	74	68·1	28·9	134	123·3	52·4	194	178·6	75·8	254	233·8	99·2
15	13·8	5·9	75	69·0	29·3	135	124·3	52·7	195	179·5	76·2	255	234·7	99·6
16	14·7	6·3	76	70·0	29·7	136	125·2	53·1	196	180·4	76·6	256	235·6	100·0
17	15·6	6·6	77	70·9	30·1	137	126·1	53·5	197	181·3	77·0	257	236·6	100·4
18	16·6	7·0	78	71·8	30·5	138	127·0	53·9	198	182·3	77·4	258	237·5	100·8
19	17·5	7·4	79	72·7	30·9	139	128·0	54·3	199	183·2	77·8	259	238·4	101·2
20	18·4	7·8	80	73·6	31·3	140	128·9	54·7	200	184·1	78·1	260	239·3	101·6
21	19·3	8·2	81	74·6	31·6	141	129·8	55·1	201	185·0	78·5	261	240·3	102·0
22	20·3	8·6	82	75·5	32·0	142	130·7	55·5	202	185·9	78·9	262	241·2	102·4
23	21·2	9·0	83	76·4	32·4	143	131·6	55·9	203	186·9	79·3	263	242·1	102·8
24	22·1	9·4	84	77·3	32·8	144	132·6	56·3	204	187·8	79·7	264	243·0	103·2
25	23·0	9·8	85	78·2	33·2	145	133·5	56·7	205	188·7	80·1	265	243·9	103·5
26	23·9	10·2	86	79·2	33·6	146	134·4	57·0	206	189·6	80·5	266	244·9	103·9
27	24·9	10·5	87	80·1	34·0	147	135·3	57·4	207	190·5	80·9	267	245·8	104·3
28	25·8	10·9	88	81·0	34·4	148	136·2	57·8	208	191·5	81·3	268	246·7	104·7
29	26·7	11·3	89	81·9	34·8	149	137·2	58·2	209	192·4	81·7	269	247·6	105·1
30	27·6	11·7	90	82·8	35·2	150	138·1	58·6	210	193·3	82·1	270	248·5	105·5
31	28·5	12·1	91	83·8	35·6	151	139·0	59·0	211	194·2	82·4	271	249·5	105·9
32	29·5	12·5	92	84·7	35·9	152	139·9	59·4	212	195·1	82·8	272	250·4	106·3
33	30·4	12·9	93	85·6	36·3	153	140·8	59·8	213	196·1	83·2	273	251·3	106·7
34	31·3	13·3	94	86·5	36·7	154	141·8	60·2	214	197·0	83·6	274	252·2	107·1
35	32·2	13·7	95	87·4	37·1	155	142·7	60·6	215	197·9	84·0	275	253·1	107·5
36	33·1	14·1	96	88·4	37·5	156	143·6	61·0	216	198·8	84·4	276	254·1	107·8
37	34·1	14·5	97	89·3	37·9	157	144·5	61·3	217	199·7	84·8	277	255·0	108·2
38	35·0	14·8	98	90·2	38·3	158	145·4	61·7	218	200·7	85·2	278	255·9	108·6
39	35·9	15·2	99	91·1	38·7	159	146·4	62·1	219	201·6	85·6	279	256·8	109·0
40	36·8	15·6	100	92·1	39·1	160	147·3	62·5	220	202·5	86·0	280	257·7	109·4
41	37·7	16·0	101	93·0	39·5	161	148·2	62·9	221	203·4	86·4	281	258·7	109·8
42	38·7	16·4	102	93·9	39·9	162	149·1	63·3	222	204·4	86·7	282	259·6	110·2
43	39·6	16·8	103	94·8	40·2	163	150·0	63·7	223	205·3	87·1	283	260·5	110·6
44	40·5	17·2	104	95·7	40·6	164	151·0	64·1	224	206·2	87·5	284	261·4	111·0
45	41·4	17·6	105	96·7	41·0	165	151·9	64·5	225	207·1	87·9	285	262·3	111·4
46	42·3	18·0	106	97·6	41·4	166	152·8	64·9	226	208·0	88·3	286	263·3	111·7
47	43·3	18·4	107	98·5	41·8	167	153·7	65·3	227	209·0	88·7	287	264·2	112·1
48	44·2	18·8	108	99·4	42·2	168	154·6	65·6	228	209·9	89·1	288	265·1	112·5
49	45·1	19·1	109	100·3	42·6	169	155·6	66·0	229	210·8	89·5	289	266·0	112·9
50	46·0	19·5	110	101·3	43·0	170	156·5	66·4	230	211·7	89·9	290	266·9	113·3
51	46·9	19·9	111	102·2	43·4	171	157·4	66·8	231	212·6	90·3	291	267·9	113·7
52	47·9	20·3	112	103·1	43·8	172	158·3	67·2	232	213·6	90·6	292	268·8	114·1
53	48·8	20·7	113	104·0	44·2	173	159·2	67·6	233	214·5	91·0	293	269·7	114·5
54	49·7	21·1	114	104·9	44·5	174	160·2	68·0	234	215·4	91·4	294	270·6	114·9
55	50·6	21·5	115	105·9	44·9	175	161·1	68·4	235	216·3	91·8	295	271·5	115·3
56	51·5	21·9	116	106·8	45·3	176	162·0	68·8	236	217·2	92·2	296	272·5	115·7
57	52·5	22·3	117	107·7	45·7	177	162·9	69·2	237	218·2	92·6	297	273·4	116·0
58	53·4	22·7	118	108·6	46·1	178	163·8	69·6	238	219·1	93·0	298	274·3	116·4
59	54·3	23·1	119	109·5	46·5	179	164·8	69·9	239	220·0	93·4	299	275·2	116·8
60	55·2	23·4	120	110·5	46·9	180	165·7	70·3	240	220·9	93·8	300	276·2	117·2
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

67° 4h 28m

TRAVERSE TABLE TO DEGREES

23° 1ʰ 32ᵐ

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	277·1	117·6	361	332·3	141·1	421	387·5	164·5	481	442·7	188·0	541	498·0	211·4
302	278·0	118·0	362	333·2	141·5	422	388·5	164·9	482	443·7	188·4	542	498·9	211·8
303	278·9	118·4	363	334·1	141·8	423	389·4	165·3	483	444·6	188·8	543	499·8	212·2
304	279·8	118·8	364	335·1	142·2	424	390·3	165·7	484	445·5	189·2	544	500·7	212·6
305	280·8	119·2	365	336·0	142·6	425	391·2	166·1	485	446·4	189·5	545	501·7	213·0
306	281·7	119·6	366	336·9	143·0	426	392·1	166·5	486	447·3	189·9	546	502·6	213·4
307	282·6	120·0	367	337·8	143·4	427	393·1	166·8	487	448·3	190·2	547	503·5	213·8
308	283·5	120·4	368	338·7	143·8	428	394·0	167·2	488	449·2	190·6	548	504·4	214·2
309	284·4	120·8	369	339·7	144·2	429	394·9	167·6	489	450·1	191·0	549	505·3	214·6
310	285·4	121·2	370	340·6	144·6	430	395·8	168·0	490	451·0	191·4	550	506·3	215·0
311	286·3	121·6	371	341·5	145·0	431	396·7	168·4	491	451·9	191·8	551	507·2	215·3
312	287·2	121·9	372	342·4	145·4	432	397·7	168·8	492	452·9	192·2	552	508·1	215·6
313	288·1	122·3	373	343·4	145·7	433	398·6	169·2	493	453·8	192·6	553	509·0	216·0
314	289·0	122·7	374	344·3	146·1	434	399·5	169·6	494	454·7	193·0	554	509·9	216·4
315	290·0	123·1	375	345·2	146·5	435	400·4	170·0	495	455·6	193·4	555	510·9	216·8
316	290·9	123·5	376	346·1	146·9	436	401·3	170·4	496	456·6	193·8	556	511·8	217·2
317	291·8	123·9	377	347·0	147·3	437	402·3	170·8	497	457·5	194·2	557	512·7	217·6
318	292·7	124·3	378	348·0	147·7	438	403·2	171·1	498	458·4	194·6	558	513·6	218·0
319	293·6	124·6	379	348·9	148·1	439	404·1	171·5	499	459·3	195·0	559	514·5	218·4
320	294·6	125·0	380	349·8	148·5	440	405·0	171·9	500	460·2	195·4	560	515·5	218·8
321	295·5	125·4	381	350·7	148·9	441	405·9	172·3	501	461·2	195·8	561	516·4	219·2
322	296·4	125·8	382	351·6	149·3	442	406·9	172·7	502	462·1	196·2	562	517·3	219·6
323	297·3	126·2	383	352·6	149·7	443	407·8	173·1	503	463·0	196·6	563	518·2	220·0
324	298·2	126·6	384	353·5	150·0	444	408·7	173·5	504	463·9	197·0	564	519·2	220·4
325	299·2	127·0	385	354·4	150·4	445	409·6	173·9	505	464·9	197·4	565	520·1	220·8
326	300·1	127·4	386	355·3	150·8	446	410·5	174·3	506	465·8	197·8	566	521·0	221·2
327	301·0	127·8	387	356·2	151·2	447	411·5	174·7	507	466·7	198·1	567	521·9	221·6
328	301·9	128·2	388	357·2	151·6	448	412·4	175·1	508	467·6	198·5	568	522·8	222·0
329	302·8	128·6	389	358·1	152·0	449	413·3	175·4	509	468·5	198·8	569	523·8	222·3
330	303·8	128·9	390	359·0	152·4	450	414·2	175·8	510	469·5	199·3	570	524·7	222·7
331	304·7	129·3	391	359·9	152·8	451	415·2	176·2	511	470·4	199·7	571	525·6	223·1
332	305·6	129·7	392	360·8	153·2	452	416·1	176·6	512	471·3	200·0	572	526·5	223·4
333	306·5	130·1	393	361·8	153·6	453	417·0	177·0	513	472·2	200·4	573	527·4	223·8
334	307·5	130·5	394	362·7	154·0	454	417·9	177·4	514	473·1	200·8	574	528·4	224·2
335	308·4	130·9	395	363·6	154·3	455	418·8	177·8	515	474·0	201·2	575	529·3	224·6
336	309·3	131·3	396	364·5	154·7	456	419·8	178·2	516	475·0	201·6	576	530·2	225·0
337	310·2	131·7	397	365·4	155·1	457	420·7	178·6	517	475·9	202·0	577	531·1	225·4
338	311·1	132·1	398	366·4	155·5	458	421·6	179·0	518	476·8	202·4	578	532·0	225·8
339	312·1	132·5	399	367·3	155·9	459	422·5	179·4	519	477·7	202·8	579	533·0	226·2
340	313·0	132·9	400	368·2	156·3	460	423·4	179·7	520	478·6	203·2	580	533·9	226·6
341	313·9	133·2	401	369·1	156·7	461	424·4	180·1	521	479·6	203·6	581	534·8	227·0
342	314·8	133·6	402	370·0	157·1	462	425·3	180·5	522	480·5	204·0	582	535·7	227·4
343	315·7	134·0	403	371·0	157·5	463	426·2	180·9	523	481·4	204·4	583	536·6	227·8
344	316·7	134·4	404	371·9	157·9	464	427·1	181·3	524	482·3	204·8	584	537·6	228·2
345	317·6	134·8	405	372·8	158·3	465	428·0	181·7	525	483·2	205·2	585	538·5	228·6
346	318·5	135·2	406	373·7	158·6	466	429·0	182·1	526	484·2	205·5	586	539·4	229·0
347	319·4	135·6	407	374·6	159·0	467	429·9	182·5	527	485·1	205·9	587	540·3	229·4
348	320·3	136·0	408	375·6	159·4	468	430·8	182·9	528	486·0	206·3	588	541·2	229·8
349	321·3	136·4	409	376·5	159·8	469	431·7	183·3	529	486·9	206·7	589	542·2	230·2
350	322·2	136·8	410	377·4	160·2	470	432·6	183·7	530	487·8	207·1	590	543·1	230·6
351	323·1	137·2	411	378·3	160·6	471	433·6	184·0	531	488·8	207·4	591	544·0	231·0
352	324·0	137·5	412	379·3	161·0	472	434·5	184·4	532	489·7	207·8	592	544·9	231·3
353	324·9	137·9	413	380·2	161·4	473	435·4	184·8	533	490·6	208·2	593	545·8	231·7
354	325·9	138·3	414	381·1	161·8	474	436·3	185·2	534	491·5	208·6	594	546·8	232·0
355	326·8	138·7	415	382·0	162·2	475	437·2	185·6	535	492·5	209·0	595	547·7	232·4
356	327·7	139·1	416	382·9	162·5	476	438·2	186·0	536	493·4	209·4	596	548·6	232·8
357	328·6	139·5	417	383·9	162·9	477	439·1	186·4	537	494·3	209·8	597	549·5	233·2
358	329·5	139·9	418	384·8	163·3	478	440·0	186·8	538	495·2	210·2	598	550·4	233·6
359	330·5	140·3	419	385·7	163·7	479	440·9	187·2	539	496·1	210·6	599	551·3	234·0
360	331·4	140·7	420	386·6	164·1	480	441·8	187·6	540	497·1	211·0	600	552·3	234·4
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

67° 4ʰ 28ᵐ

TRAVERSE TABLE TO DEGREES

24° 1h 36m

Dist.	D.Lat	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0.9	0.4	61	55.7	24.8	121	110.5	49.2	181	165.4	73.6	241	220.2	98.0
2	1.8	0.8	62	56.6	25.2	122	111.5	49.6	182	166.3	74.0	242	221.1	98.4
3	2.7	1.2	63	57.6	25.6	123	112.4	50.0	183	167.2	74.4	243	222.0	98.8
4	3.7	1.6	64	58.5	26.0	124	113.3	50.4	184	168.1	74.8	244	222.9	99.2
5	4.6	2.0	65	59.4	26.4	125	114.2	50.8	185	169.0	75.2	245	223.8	99.7
6	5.5	2.4	66	60.3	26.8	126	115.1	51.2	186	169.9	75.7	246	224.7	100.1
7	6.4	2.8	67	61.2	27.3	127	116.0	51.7	187	170.8	76.1	247	225.6	100.5
8	7.3	3.3	68	62.1	27.7	128	116.9	52.1	188	171.7	76.5	248	226.6	100.9
9	8.2	3.7	69	63.0	28.1	129	117.8	52.5	189	172.7	76.9	249	227.5	101.3
10	9.1	4.1	70	63.9	28.5	130	118.8	52.9	190	173.6	77.3	250	228.4	101.7
11	10.0	4.5	71	64.9	28.9	131	119.7	53.3	191	174.5	77.7	251	229.3	102.1
12	11.0	4.9	72	65.8	29.3	132	120.6	53.7	192	175.4	78.1	252	230.2	102.5
13	11.9	5.3	73	66.7	29.7	133	121.5	54.1	193	176.3	78.5	253	231.1	102.9
14	12.8	5.7	74	67.6	30.1	134	122.4	54.5	194	177.2	78.9	254	232.0	103.3
15	13.7	6.1	75	68.5	30.5	135	123.3	54.9	195	178.1	79.3	255	233.0	103.7
16	14.6	6.5	76	69.4	30.9	136	124.2	55.3	196	179.1	79.7	256	233.9	104.1
17	15.5	6.9	77	70.3	31.3	137	125.2	55.7	197	180.0	80.1	257	234.8	104.5
18	16.4	7.3	78	71.3	31.7	138	126.1	56.1	198	180.9	80.5	258	235.7	104.9
19	17.4	7.7	79	72.2	32.1	139	127.0	56.5	199	181.8	80.9	259	236.6	105.3
20	18.3	8.1	80	73.1	32.5	140	127.9	56.9	200	182.7	81.3	260	237.5	105.8
21	19.2	8.5	81	74.0	32.9	141	128.8	57.3	201	183.6	81.8	261	238.4	106.2
22	20.1	8.9	82	74.9	33.4	142	129.7	57.8	202	184.5	82.2	262	239.3	106.6
23	21.0	9.4	83	75.8	33.8	143	130.6	58.2	203	185.4	82.6	263	240.3	107.0
24	21.9	9.8	84	76.7	34.2	144	131.6	58.6	204	186.4	83.0	264	241.2	107.4
25	22.8	10.2	85	77.7	34.6	145	132.5	59.0	205	187.3	83.4	265	242.1	107.8
26	23.8	10.6	86	78.6	35.0	146	133.4	59.4	206	188.2	83.8	266	243.0	108.2
27	24.7	11.0	87	79.5	35.4	147	134.3	59.8	207	189.1	84.2	267	243.9	108.6
28	25.6	11.4	88	80.4	35.8	148	135.2	60.2	208	190.0	84.6	268	244.8	109.0
29	26.5	11.8	89	81.3	36.2	149	136.1	60.6	209	190.9	85.0	269	245.7	109.4
30	27.4	12.2	90	82.2	36.6	150	137.0	61.0	210	191.8	85.4	270	246.7	109.8
31	28.3	12.6	91	83.1	37.0	151	137.9	61.4	211	192.8	85.8	271	247.6	110.2
32	29.2	13.0	92	84.0	37.4	152	138.9	61.8	212	193.7	86.2	272	248.5	110.6
33	30.1	13.4	93	85.0	37.8	153	139.8	62.2	213	194.6	86.6	273	249.4	111.0
34	31.1	13.8	94	85.9	38.2	154	140.7	62.6	214	195.5	87.0	274	250.3	111.4
35	32.0	14.2	95	86.8	38.6	155	141.6	63.0	215	196.4	87.4	275	251.2	111.9
36	32.9	14.6	96	87.7	39.0	156	142.5	63.5	216	197.3	87.9	276	252.1	112.3
37	33.8	15.0	97	88.6	39.5	157	143.4	63.9	217	198.2	88.3	277	253.1	112.7
38	34.7	15.5	98	89.5	39.9	158	144.3	64.3	218	199.2	88.7	278	254.0	113.1
39	35.6	15.9	99	90.4	40.3	159	145.3	64.7	219	200.1	89.1	279	254.9	113.5
40	36.5	16.3	100	91.4	40.7	160	146.2	65.1	220	201.0	89.5	280	255.8	113.9
41	37.5	16.7	101	92.3	41.1	161	147.1	65.5	221	201.9	89.9	281	256.7	114.3
42	38.4	17.1	102	93.2	41.5	162	148.0	65.9	222	202.8	90.3	282	257.6	114.7
43	39.3	17.5	103	94.1	41.9	163	148.9	66.3	223	203.7	90.7	283	258.5	115.1
44	40.2	17.9	104	95.0	42.3	164	149.8	66.7	224	204.6	91.1	284	259.4	115.5
45	41.1	18.3	105	95.9	42.7	165	150.7	67.1	225	205.5	91.5	285	260.4	115.9
46	42.0	18.7	106	96.8	43.1	166	151.6	67.5	226	206.5	91.9	286	261.3	116.3
47	42.9	19.1	107	97.7	43.5	167	152.6	67.9	227	207.4	92.3	287	262.2	116.7
48	43.9	19.5	108	98.7	43.9	168	153.5	68.3	228	208.3	92.7	288	263.1	117.1
49	44.8	19.9	109	99.6	44.3	169	154.4	68.7	229	209.2	93.1	289	264.0	117.5
50	45.7	20.3	110	100.5	44.7	170	155.3	69.1	230	210.1	93.5	290	264.9	118.0
51	46.6	20.7	111	101.4	45.1	171	156.2	69.6	231	211.0	94.0	291	265.8	118.4
52	47.5	21.2	112	102.3	45.6	172	157.1	70.0	232	211.9	94.4	292	266.8	118.8
53	48.4	21.6	113	103.2	46.0	173	158.0	70.4	233	212.9	94.8	293	267.7	119.2
54	49.3	22.0	114	104.1	46.4	174	159.0	70.8	234	213.8	95.2	294	268.6	119.6
55	50.2	22.4	115	105.1	46.8	175	159.9	71.2	235	214.7	95.6	295	269.5	120.0
56	51.2	22.8	116	106.0	47.2	176	160.8	71.6	236	215.6	96.0	296	270.4	120.4
57	52.1	23.2	117	106.9	47.6	177	161.7	72.0	237	216.5	96.4	297	271.3	120.8
58	53.0	23.6	118	107.8	48.0	178	162.6	72.4	238	217.4	96.8	298	272.2	121.2
59	53.9	24.0	119	108.7	48.4	179	163.5	72.8	239	218.3	97.2	299	273.2	121.6
60	54.8	24.4	120	109.6	48.8	180	164.4	73.2	240	219.3	97.6	300	274.1	122.0
Dist.	Dep.	D.Lat	Dist.	Dep.	D.Lat	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat.

66° 4h 24m

TRAVERSE TABLE TO DEGREES

24° 1h 36m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat	Dep.
301	275.0	122.4	361	329.8	146.8	421	384.6	171.2	481	439.4	195.6	541	494.2	220.0
302	275.9	122.8	362	330.7	147.2	422	385.5	171.6	482	440.3	196.0	542	495.1	220.4
303	276.8	123.2	363	331.6	147.6	423	386.4	172.1	483	441.2	196.5	543	496.0	220.9
304	277.7	123.7	364	332.5	148.1	424	387.3	172.5	484	442.1	196.9	544	496.9	221.3
305	278.6	124.1	365	333.4	148.5	425	388.2	172.9	485	443.0	197.3	545	497.8	221.7
306	279.5	124.5	366	334.3	148.9	426	389.2	173.3	486	444.0	197.7	546	498.8	222.1
307	280.4	124.9	367	335.3	149.3	427	390.1	173.7	487	444.9	198.1	547	499.7	222.5
308	281.4	125.3	368	336.2	149.7	428	391.0	174.1	488	445.8	198.5	548	500.6	222.9
309	282.3	125.7	369	337.1	150.1	429	391.9	174.5	489	446.7	198.9	549	501.5	223.3
310	283.2	126.1	370	338.0	150.5	430	392.8	174.9	490	447.6	199.3	550	502.4	223.7
311	284.1	126.5	371	338.9	150.9	431	393.7	175.3	491	448.6	199.7	551	503.4	224.1
312	285.0	126.9	272	339.8	151.3	432	394.6	175.7	492	449.5	200.1	552	504.3	224.5
313	285.9	127.3	373	340.7	151.7	433	395.6	176.1	493	450.4	200.5	553	505.2	224.9
314	286.8	127.7	374	341.7	152.1	434	396.5	176.5	494	451.3	200.9	554	506.1	225.3
315	287.8	128.1	375	342.6	152.5	435	397.4	176.9	495	452.2	201.3	555	507.0	225.7
316	288.7	128.5	376	343.5	152.9	436	398.3	177.3	496	453.1	201.7	556	507.9	226.1
317	289.6	128.9	377	344.4	153.3	437	399.2	177.7	497	454.0	202.2	557	508.8	226.6
318	290.5	129.3	378	345.3	153.7	438	400.1	178.2	498	454.9	202.6	558	509.7	227.0
319	291.4	129.8	379	346.2	154.2	439	401.0	178.6	499	455.8	203.0	559	510.6	227.4
320	292.3	130.2	380	347.1	154.6	440	402.0	179.0	500	456.8	203.4	560	511.6	227.8
321	293.2	130.6	381	348.1	155.0	441	402.9	179.4	501	457.7	203.8	561	512.5	228.2
322	294.2	131.0	382	349.0	155.4	442	403.8	179.8	502	458.6	204.2	562	513.4	228.6
323	295.1	131.4	383	349.9	155.8	443	404.7	180.2	503	459.5	204.6	563	514.3	229.0
324	296.0	131.8	384	350.8	156.2	444	405.6	180.6	504	460.4	205.0	564	515.2	229.4
325	296.9	132.2	385	351.7	156.6	445	406.5	181.0	505	461.3	205.4	565	516.1	229.8
326	297.8	132.6	386	352.6	157.0	446	407.4	181.4	506	462.2	205.8	566	517.0	230.2
327	298.7	133.0	387	353.5	157.4	447	408.3	181.8	507	463.2	206.2	567	518.0	230.6
328	299.6	133.4	388	354.4	157.8	448	409.3	182.2	508	464.1	206.6	568	518.9	231.0
329	300.5	133.8	389	355.4	158.2	449	410.2	182.6	509	465.0	207.0	569	519.8	231.4
330	301.5	134.2	390	356.3	158.6	450	411.1	183.0	510	465.9	207.4	570	520.7	231.8
331	302.4	134.6	391	357.2	159.0	451	412.0	183.4	511	466.8	207.8	571	521.6	232.2
332	303.3	135.0	392	358.1	159.4	452	412.9	183.8	512	467.7	208.2	572	522.5	232.7
333	304.2	135.4	393	359.0	159.8	453	413.8	184.3	513	468.6	208.7	573	523.4	233.1
334	305.1	135.9	394	359.9	160.3	454	414.7	184.7	514	469.5	209.1	574	524.3	233.5
335	306.0	136.3	395	360.8	160.7	455	415.7	185.1	515	470.5	209.5	575	525.3	233.9
336	306.9	136.7	396	361.8	161.1	456	416.6	185.5	516	471.4	209.9	576	526.2	234.3
337	307.9	137.1	397	362.7	161.5	457	417.5	185.9	517	472.3	210.3	577	527.1	234.7
338	308.8	137.5	398	363.6	161.9	458	418.4	186.3	518	473.2	210.7	578	528.0	235.1
339	309.7	137.9	399	364.5	162.3	459	419.3	186.7	519	474.1	211.1	579	528.9	235.5
340	310.6	138.3	400	365.4	162.7	460	420.2	187.1	520	475.0	211.5	580	529.8	235.9
341	311.5	138.7	401	366.3	163.1	461	421.1	187.5	521	475.9	211.9	581	530.8	236.3
342	312.4	139.1	402	367.2	163.5	462	422.0	187.9	522	476.8	212.3	582	531.7	236.7
343	313.3	139.5	403	368.2	163.9	463	423.0	188.3	523	477.8	212.7	583	532.6	237.1
344	314.3	139.9	404	369.1	164.3	464	423.9	188.7	524	478.7	213.1	584	533.5	237.5
345	315.2	140.3	405	370.0	164.7	465	424.8	189.1	525	479.6	213.5	585	534.4	237.9
346	316.1	140.7	406	370.9	165.1	466	425.7	189.5	526	480.5	213.9	586	535.3	238.3
347	317.0	141.1	407	371.8	165.5	467	426.6	189.9	527	481.4	214.4	587	536.2	238.8
348	317.9	141.5	408	372.7	165.9	468	427.5	190.4	528	482.3	214.8	588	537.1	239.2
349	318.8	142.0	409	373.6	166.4	469	428.4	190.8	529	483.2	215.2	589	538.0	239.6
350	319.7	142.4	410	374.5	166.8	470	429.4	191.2	530	484.2	215.6	590	539.0	240.0
351	320.6	142.8	411	375.5	167.2	471	430.3	191.6	531	485.1	216.0	591	539.9	240.4
352	321.6	143.2	412	376.4	167.6	472	431.2	192.0	532	486.0	216.4	592	540.8	240.8
353	322.5	143.6	413	377.3	168.0	473	432.1	192.4	533	486.9	216.8	593	541.7	241.2
354	323.4	144.0	414	378.2	168.4	474	433.0	192.8	534	487.8	217.2	594	542.6	241.6
355	324.3	144.4	415	379.1	168.8	475	433.9	193.2	535	488.7	217.6	595	543.5	242.0
356	325.2	144.8	416	380.0	169.2	476	434.8	193.6	536	489.6	218.0	596	544.4	242.4
357	326.1	145.2	417	380.9	169.6	477	435.8	194.0	537	490.6	218.4	597	545.4	242.8
358	327.0	145.6	418	381.9	170.0	478	436.7	194.4	538	491.5	218.8	598	546.3	243.2
359	328.0	146.0	419	382.8	170.4	479	437.6	194.8	539	492.4	219.2	599	547.2	243.6
360	328.9	146.4	420	383.7	170.8	480	438.5	195.2	540	493.3	219.6	600	548.1	244.0
Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat

66° 4h 24m

TRAVERSE TABLE TO DEGREES

25° 1h 40m

Dist.	D.Lat	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·9	0·4	61	55·3	25·8	121	109·7	51·1	181	164·0	76·5	241	218·4	101·9
2	1·8	0·8	62	56·2	26·2	122	110·6	51·6	182	164·9	76·9	242	219·3	102·3
3	2·7	1·3	63	57·1	26·6	123	111·5	52·0	183	165·9	77·3	243	220·2	102·7
4	3·6	1·7	64	58·0	27·0	124	112·4	52·4	184	166·8	77·8	244	221·1	103·1
5	4·5	2·1	65	58·9	27·5	125	113·3	52·8	185	167·7	78·2	245	222·0	103·5
6	5·4	2·5	66	59·8	27·9	126	114·2	53·2	186	168·6	78·6	246	223·0	104·0
7	6·3	3·0	67	60·7	28·3	127	115·1	53·7	187	169·5	79·0	247	223·9	104·4
8	7·3	3·4	68	61·6	28·7	128	116·0	54·1	188	170·4	79·5	248	224·8	104·8
9	8·2	3·8	69	62·5	29·2	129	116·9	54·5	189	171·3	79·9	249	225·7	105·2
10	9·1	4·2	70	63·4	29·6	130	117·8	54·9	190	172·2	80·3	250	226·6	105·7
11	10·0	4·6	71	64·3	30·0	131	118·7	55·4	191	173·1	80·7	251	227·5	106·1
12	10·9	5·1	72	65·3	30·4	132	119·6	55·8	192	174·0	81·1	252	228·4	106·5
13	11·8	5·5	73	66·2	30·9	133	120·5	56·2	193	174·9	81·6	253	229·3	106·9
14	12·7	5·9	74	67·1	31·3	134	121·4	56·6	194	175·8	82·0	254	230·2	107·3
15	13·6	6·3	75	68·0	31·7	135	122·4	57·1	195	176·7	82·4	255	231·1	107·8
16	14·5	6·8	76	68·9	32·1	136	123·3	57·5	196	177·6	82·8	256	232·0	108·2
17	15·4	7·2	77	69·8	32·5	137	124·2	57·9	197	178·5	83·3	257	232·9	108·6
18	16·3	7·6	78	70·7	33·0	138	125·1	58·3	198	179·4	83·7	258	233·8	109·0
19	17·2	8·0	79	71·6	33·4	139	126·0	58·7	199	180·4	84·1	259	234·7	109·5
20	18·1	8·5	80	72·5	33·8	140	126·9	59·2	200	181·3	84·5	260	235·6	109·9
21	19·0	8·9	81	73·4	34·2	141	127·8	59·6	201	182·2	84·9	261	236·5	110·3
22	19·9	9·3	82	74·3	34·7	142	128·7	60·0	202	183·1	85·4	262	237·5	110·7
23	20·8	9·7	83	75·2	35·1	143	129·6	60·4	203	184·0	85·8	263	238·4	111·1
24	21·8	10·1	84	76·1	35·5	144	130·5	60·9	204	184·9	86·2	264	239·3	111·6
25	22·7	10·6	85	77·0	35·9	145	131·4	61·3	205	185·8	86·6	265	240·2	112·0
26	23·6	11·0	86	77·9	36·3	146	132·3	61·7	206	186·7	87·1	266	241·1	112·4
27	24·5	11·4	87	78·8	36·8	147	133·2	62·1	207	187·6	87·5	267	242·0	112·8
28	25·4	11·8	88	79·8	37·2	148	134·1	62·5	208	188·5	87·9	268	242·9	113·3
29	26·3	12·3	89	80·7	37·6	149	135·0	63·0	209	189·4	88·3	269	243·8	113·7
30	27·2	12·7	90	81·6	38·0	150	135·9	63·4	210	190·3	88·7	270	244·7	114·1
31	28·1	13·1	91	82·5	38·5	151	136·9	63·8	211	191·2	89·2	271	245·6	114·5
32	29·0	13·5	92	83·4	38·9	152	137·8	64·2	212	192·1	89·6	272	246·5	115·0
33	29·9	13·9	93	84·3	39·3	153	138·7	64·7	213	193·0	90·0	273	247·4	115·4
34	30·8	14·4	94	85·2	39·7	154	139·6	65·1	214	193·9	90·4	274	248·3	115·8
35	31·7	14·8	95	86·1	40·1	155	140·5	65·5	215	194·9	90·9	275	249·2	116·2
36	32·6	15·2	96	87·0	40·6	156	141·4	65·9	216	195·8	91·3	276	250·1	116·6
37	33·5	15·6	97	87·9	41·0	157	142·3	66·4	217	196·7	91·7	277	251·0	117·1
38	34·4	16·1	98	88·8	41·4	158	143·2	66·8	218	197·6	92·1	278	252·0	117·5
39	35·3	16·5	99	89·7	41·8	159	144·1	67·2	219	198·5	92·6	279	252·9	117·9
40	36·3	16·9	100	90·6	42·3	160	145·0	67·6	220	199·4	93·0	280	253·8	118·3
41	37·2	17·3	101	91·5	42·7	161	145·9	68·0	221	200·3	93·4	281	254·7	118·8
42	38·1	17·7	102	92·4	43·1	162	146·8	68·5	222	201·2	93·8	282	255·6	119·2
43	39·0	18·2	103	93·3	43·5	163	147·7	68·9	223	202·1	94·2	283	256·5	119·6
44	39·9	18·6	104	94·3	44·0	164	148·6	69·3	224	203·0	94·7	284	257·4	120·0
45	40·8	19·0	105	95·2	44·4	165	149·5	69·7	225	203·9	95·1	285	258·3	120·4
46	41·7	19·4	106	96·1	44·8	166	150·4	70·2	226	204·8	95·5	286	259·2	120·9
47	42·6	19·9	107	97·0	45·2	167	151·4	70·6	227	205·7	95·9	287	260·1	121·3
48	43·5	20·3	108	97·9	45·6	168	152·3	71·0	228	206·6	96·4	288	261·0	121·7
49	44·4	20·7	109	98·8	46·1	169	153·2	71·4	229	207·5	96·8	289	261·9	122·1
50	45·3	21·1	110	99·7	46·5	170	154·1	71·8	230	208·5	97·2	290	262·8	122·6
51	46·2	21·6	111	100·6	46·9	171	155·0	72·3	231	209·4	97·6	291	263·7	123·0
52	47·1	22·0	112	101·5	47·3	172	155·9	72·7	232	210·3	98·0	292	264·6	123·4
53	48·0	22·4	113	102·4	47·8	173	156·8	73·1	233	211·2	98·5	293	265·5	123·8
54	48·9	22·8	114	103·3	48·2	174	157·7	73·5	234	212·1	98·9	294	266·5	124·2
55	49·8	23·2	115	104·2	48·6	175	158·6	74·0	235	213·0	99·3	295	267·4	124·7
56	50·8	23·7	116	105·1	49·0	176	159·5	74·4	236	213·9	99·7	296	268·3	125·1
57	51·7	24·1	117	106·0	49·4	177	160·4	74·8	237	214·8	100·2	297	269·2	125·5
58	52·6	24·5	118	106·9	49·9	178	161·3	75·2	238	215·7	100·6	298	270·1	125·9
59	53·5	24·9	119	107·9	50·3	179	162·2	75·6	239	216·6	101·0	299	271·0	126·4
60	54·4	25·4	120	108·8	50·7	180	163·1	76·1	240	217·5	101·4	300	271·9	126·8
Dist.	Dep.	D.Lat	Dist.	Dep.	D.Lat	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat

65° 4h 20m

TRAVERSE TABLE TO DEGREES

25° — $1^h\ 40^m$

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	272.8	127.2	361	327.1	152.5	421	381.5	177.9	481	435.9	203.3	541	490.3	228.6
302	273.7	127.6	362	328.0	153.0	422	382.4	178.3	482	436.8	203.7	542	491.2	229.0
303	274.6	128.0	363	329.0	153.4	423	383.3	178.7	483	437.7	204.1	543	492.1	229.4
304	275.5	128.4	364	329.9	153.8	424	384.2	179.2	484	438.6	204.5	544	493.0	229.9
305	276.4	128.9	365	330.8	154.2	425	385.1	179.6	485	439.5	204.9	545	493.9	230.3
306	277.3	129.3	366	331.7	154.6	426	386.0	180.0	486	440.4	205.4	546	494.8	230.7
307	278.2	129.7	367	332.6	155.1	427	387.0	180.4	487	441.3	205.8	547	495.7	231.1
308	279.1	130.1	368	333.5	155.5	428	387.9	180.9	488	442.2	206.2	548	496.6	231.6
309	280.0	130.6	369	334.4	155.9	429	388.8	181.3	489	443.1	206.6	549	497.5	232.0
310	280.9	131.0	370	335.3	156.3	430	389.7	181.7	490	444.0	207.1	550	498.4	232.4
311	281.8	131.4	371	336.2	156.8	431	390.6	182.1	491	444.9	207.5	551	499.3	232.8
312	282.7	131.8	372	337.1	157.2	432	391.5	182.5	492	445.9	207.9	552	500.2	233.2
313	283.6	132.2	373	338.0	157.6	433	392.4	183.0	493	446.8	208.3	553	501.1	233.7
314	284.5	132.7	374	338.9	158.0	434	393.3	183.4	494	447.7	208.7	554	502.0	234.1
315	285.4	133.1	375	339.8	158.5	435	394.2	183.8	495	448.6	209.1	555	503.0	234.5
316	286.4	133.5	376	340.7	158.9	436	395.1	184.2	496	449.5	209.6	556	503.9	235.0
317	287.3	133.9	377	341.6	159.3	437	396.0	184.7	497	450.4	210.0	557	504.8	235.4
318	288.2	134.4	378	342.5	159.7	438	396.9	185.1	498	451.3	210.4	558	505.7	235.8
319	289.1	134.8	379	343.5	160.1	439	397.8	185.5	499	452.2	210.9	559	506.6	236.2
320	290.0	135.2	380	344.4	160.6	440	398.7	185.9	500	453.1	211.3	560	507.5	236.6
321	290.9	135.6	381	345.3	161.0	441	399.6	186.3	501	454.0	211.7	561	508.4	237.1
322	291.8	136.1	382	346.2	161.4	442	400.6	186.8	502	454.9	212.1	562	509.3	237.5
323	292.7	136.5	383	347.1	161.8	443	401.5	187.2	503	455.8	212.5	563	510.2	237.9
324	293.6	136.9	384	348.0	162.3	444	402.4	187.6	504	456.7	213.0	564	511.1	238.3
325	294.5	137.3	385	348.9	162.7	445	403.3	188.0	505	457.7	213.4	565	512.0	238.7
326	295.4	137.7	386	349.8	163.1	446	404.2	188.5	506	458.6	213.8	566	512.9	239.2
327	296.3	138.2	387	350.7	163.5	447	405.1	188.9	507	459.5	214.2	567	513.8	239.6
328	297.2	138.6	388	351.6	163.9	448	406.0	189.3	508	460.4	214.7	568	514.8	240.1
329	298.1	139.0	389	352.5	164.4	449	406.9	189.7	509	461.3	215.1	569	515.7	240.5
330	299.0	139.4	390	353.4	164.8	450	407.8	190.1	510	462.2	215.5	570	516.6	240.9
331	300.0	139.9	391	354.3	165.2	451	408.7	190.6	511	463.1	215.9	571	517.5	241.3
332	300.9	140.3	392	355.2	165.6	452	409.6	191.0	512	464.0	216.4	572	518.4	241.7
333	301.8	140.7	393	356.1	166.1	453	410.5	191.4	513	464.9	216.8	573	519.3	242.1
334	302.7	141.1	394	357.0	166.5	454	411.4	191.8	514	465.8	217.2	574	520.2	242.6
335	303.6	141.5	395	358.0	166.9	455	412.3	192.3	515	466.7	217.7	575	521.1	243.0
336	304.5	142.0	396	358.9	167.3	456	413.2	192.7	516	467.6	218.1	576	522.0	243.4
337	305.4	142.4	397	359.8	167.7	457	414.1	193.1	517	468.5	218.5	577	522.9	243.8
338	306.3	142.8	398	360.7	168.2	458	415.1	193.5	518	469.4	218.9	578	523.8	244.3
339	307.2	143.2	399	361.6	168.6	459	416.0	194.0	519	470.3	219.3	579	524.7	244.7
340	308.1	143.7	400	362.5	169.0	460	416.9	194.4	520	471.2	219.8	580	525.6	245.1
341	309.0	144.1	401	363.4	169.4	461	417.8	194.8	521	472.2	220.2	581	526.5	245.5
342	309.9	144.5	402	364.3	169.9	462	418.7	195.2	522	473.1	220.6	582	527.4	246.0
343	310.8	144.9	403	365.2	170.3	463	419.6	195.6	523	474.0	221.0	583	528.3	246.4
344	311.7	145.4	404	366.1	170.7	464	420.5	196.1	524	474.9	221.4	584	529.3	246.8
345	312.6	145.8	405	367.0	171.1	465	421.4	196.5	525	475.8	221.9	585	530.2	247.2
346	313.5	146.2	406	367.9	171.6	466	422.3	196.9	526	476.7	222.3	586	531.1	247.7
347	314.5	146.6	407	368.8	172.0	467	423.2	197.3	527	477.6	222.7	587	532.0	248.1
348	315.4	147.0	408	369.7	172.4	468	424.1	197.8	528	478.5	223.2	588	532.9	248.5
349	316.3	147.5	409	370.6	172.8	469	425.0	198.2	529	479.4	223.6	589	533.8	248.9
350	317.2	147.9	410	371.5	173.2	470	425.9	198.6	530	480.3	224.0	590	534.7	249.4
351	318.1	148.3	411	372.5	173.7	471	426.8	199.0	531	481.2	224.4	591	535.6	249.8
352	319.0	148.7	412	373.4	174.1	472	427.7	199.4	532	482.1	224.8	592	536.5	250.2
353	319.9	149.2	413	374.3	174.5	473	428.6	199.9	533	483.0	225.3	593	537.4	250.6
354	320.8	149.6	414	375.2	174.9	474	429.6	200.3	534	483.9	225.7	594	538.3	251.1
355	321.7	150.0	415	376.1	175.4	475	430.5	200.7	535	484.8	226.1	595	539.2	251.5
356	322.6	150.4	416	377.0	175.8	476	431.4	201.1	536	485.7	226.5	596	540.1	251.9
357	323.5	150.8	417	377.9	176.2	477	432.3	201.6	537	486.7	226.9	597	541.0	252.3
358	324.4	151.3	418	378.8	176.6	478	433.2	202.0	538	487.6	227.4	598	541.9	252.7
359	325.3	151.7	419	379.7	177.0	479	434.1	202.4	539	488.5	227.8	599	542.8	253.1
360	326.2	152.1	420	380.6	177.5	480	435.0	202.8	540	489.4	228.2	600	543.8	253.6
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

65° — $4^h\ 20^m$

TRAVERSE TABLE TO DEGREES

26° — $1^h\ 44^m$

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·9	0·4	61	54·8	26·7	121	108·8	53·0	181	162·7	79·3	241	216·6	105·6
2	1·8	0·9	62	55·7	27·2	122	109·7	53·5	182	163·6	79·8	242	217·5	106·1
3	2·7	1·3	63	56·6	27·6	123	110·6	53·9	183	164·5	80·2	243	218·4	106·5
4	3·6	1·8	64	57·5	28·1	124	111·5	54·4	184	165·4	80·7	244	219·3	107·0
5	4·5	2·2	65	58·4	28·5	125	112·3	54·8	185	166·3	81·1	245	220·2	107·4
6	5·4	2·6	66	59·3	28·9	126	113·2	55·2	186	167·2	81·5	246	221·1	107·8
7	6·3	3·1	67	60·2	29·4	127	114·1	55·7	187	168·1	82·0	247	222·0	108·3
8	7·2	3·5	68	61·1	29·8	128	115·0	56·1	188	169·0	82·4	248	222·9	108·7
9	8·1	3·9	69	62·0	30·2	129	115·9	56·5	189	169·9	82·9	249	223·8	109·2
10	9·0	4·4	70	62·9	30·7	130	116·8	57·0	190	170·8	83·3	250	224·7	109·6
11	9·9	4·8	71	63·8	31·1	131	117·7	57·4	191	171·7	83·7	251	225·6	110·0
12	10·8	5·3	72	64·7	31·6	132	118·6	57·9	192	172·6	84·2	252	226·5	110·5
13	11·7	5·7	73	65·6	32·0	133	119·5	58·3	193	173·5	84·6	253	227·4	110·9
14	12·6	6·1	74	66·5	32·4	134	120·4	58·7	194	174·4	85·0	254	228·3	111·3
15	13·5	6·6	75	67·4	32·9	135	121·3	59·2	195	175·3	85·5	255	229·2	111·8
16	14·4	7·0	76	68·3	33·3	136	122·2	59·6	196	176·2	85·9	256	230·1	112·2
17	15·3	7·5	77	69·2	33·8	137	123·1	60·1	197	177·1	86·4	257	231·0	112·7
18	16·2	7·9	78	70·1	34·2	138	124·0	60·5	198	178·0	86·8	258	231·9	113·1
19	17·1	8·3	79	71·0	34·6	139	124·9	60·9	199	178·9	87·2	259	232·8	113·5
20	18·0	8·8	80	71·9	35·1	140	125·8	61·4	200	179·8	87·7	260	233·7	114·0
21	18·9	9·2	81	72·8	35·5	141	126·7	61·8	201	180·7	88·1	261	234·6	114·4
22	19·8	9·6	82	73·7	35·9	142	127·6	62·2	202	181·6	88·6	262	235·5	114·9
23	20·7	10·1	83	74·6	36·4	143	128·5	62·7	203	182·5	89·0	263	236·4	115·3
24	21·6	10·5	84	75·5	36·8	144	129·4	63·1	204	183·4	89·4	264	237·3	115·7
25	22·5	11·0	85	76·4	37·3	145	130·3	63·6	205	184·3	89·9	265	238·2	116·2
26	23·4	11·4	86	77·3	37·7	146	131·2	64·0	206	185·2	90·3	266	239·1	116·6
27	24·3	11·8	87	78·2	38·1	147	132·1	64·4	207	186·1	90·7	267	240·0	117·0
28	25·2	12·3	88	79·1	38·6	148	133·0	64·9	208	186·9	91·2	268	240·9	117·5
29	26·1	12·7	89	80·0	39·0	149	133·9	65·3	209	187·8	91·6	269	241·8	117·9
30	27·0	13·2	90	80·9	39·5	150	134·8	65·8	210	188·7	92·1	270	242·7	118·4
31	27·9	13·6	91	81·8	39·9	151	135·7	66·2	211	189·6	92·5	271	243·6	118·8
32	28·8	14·0	92	82·7	40·3	152	136·6	66·6	212	190·5	92·9	272	244·5	119·2
33	29·7	14·5	93	83·6	40·8	153	137·5	67·1	213	191·4	93·4	273	245·4	119·7
34	30·6	14·9	94	84·5	41·2	154	138·4	67·5	214	192·3	93·8	274	246·3	120·1
35	31·5	15·3	95	85·4	41·6	155	139·3	67·9	215	193·2	94·2	275	247·2	120·6
36	32·4	15·8	96	86·3	42·1	156	140·2	68·4	216	194·1	94·7	276	248·1	121·0
37	33·3	16·2	97	87·2	42·5	157	141·1	68·8	217	195·0	95·1	277	249·0	121·4
38	34·2	16·7	98	88·1	43·0	158	142·0	69·3	218	195·9	95·6	278	249·9	121·9
39	35·1	17·1	99	89·0	43·4	159	142·9	69·7	219	196·8	96·0	279	250·8	122·3
40	36·0	17·5	100	89·9	43·8	160	143·8	70·1	220	197·7	96·4	280	251·7	122·7
41	36·9	18·0	101	90·8	44·3	161	144·7	70·6	221	198·6	96·9	281	252·6	123·2
42	37·7	18·4	102	91·7	44·7	162	145·6	71·0	222	199·5	97·3	282	253·5	123·6
43	38·6	18·8	103	92·6	45·2	163	146·5	71·5	223	200·4	97·8	283	254·4	124·1
44	39·5	19·3	104	93·5	45·6	164	147·4	71·9	224	201·3	98·2	284	255·3	124·5
45	40·4	19·7	105	94·4	46·0	165	148·3	72·3	225	202·2	98·6	285	256·2	124·9
46	41·3	20·2	106	95·3	46·5	166	149·2	72·8	226	203·1	99·1	286	257·1	125·4
47	42·2	20·6	107	96·2	46·9	167	150·1	73·2	227	204·0	99·5	287	258·0	125·8
48	43·1	21·0	108	97·1	47·3	168	151·0	73·6	228	204·9	99·9	288	258·9	126·3
49	44·0	21·5	109	98·0	47·8	169	151·9	74·1	229	205·8	100·4	289	259·8	126·7
50	44·9	21·9	110	98·9	48·2	170	152·8	74·5	230	206·7	100·8	290	260·7	127·1
51	45·8	22·4	111	99·8	48·7	171	153·7	75·0	231	207·6	101·3	291	261·5	127·6
52	46·7	22·8	112	100·7	49·1	172	154·6	75·4	232	208·5	101·7	292	262·4	128·0
53	47·6	23·2	113	101·6	49·5	173	155·5	75·8	233	209·4	102·1	293	263·3	128·4
54	48·5	23·7	114	102·5	50·0	174	156·4	76·3	234	210·3	102·6	294	264·2	128·9
55	49·4	24·1	115	103·4	50·4	175	157·3	76·7	235	211·2	103·0	295	265·1	129·3
56	50·3	24·5	116	104·3	50·9	176	158·2	77·2	236	212·1	103·5	296	266·0	129·8
57	51·2	25·0	117	105·2	51·3	177	159·1	77·6	237	213·0	103·9	297	266·9	130·2
58	52·1	25·4	118	106·1	51·7	178	160·0	78·0	238	213·9	104·3	298	267·8	130·6
59	53·0	25·9	119	107·0	52·2	179	160·9	78·5	239	214·8	104·8	299	268·7	131·1
60	53·9	26·3	120	107·9	52·6	180	161·8	78·9	240	215·7	105·2	300	269·6	131·5
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

64° — $4^h\ 16^m$

TRAVERSE TABLE TO DEGREES

26° 1h 44m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	270·5	132·0	361	324·5	158·3	421	378·4	184·6	481	432·3	210·9	541	486·2	237·2
302	271·4	132·4	362	325·4	158·7	422	379·3	185·0	482	433·2	211·3	542	487·1	237·6
303	272·3	132·8	363	326·3	159·1	423	380·2	185·4	483	434·1	211·7	543	488·0	238·0
304	273·2	133·3	364	327·2	159·6	424	381·1	185·9	484	435·0	212·2	544	488·9	238·5
305	274·1	133·7	365	328·1	160·0	425	382·0	186·3	485	435·9	212·6	545	489·8	238·9
306	275·0	134·1	366	329·0	160·4	426	382·9	186·7	486	436·8	213·0	546	490·7	239·3
307	275·9	134·6	367	329·9	160·9	427	383·8	187·2	487	437·7	213·5	547	491·6	239·8
308	276·8	135·0	368	330·8	161·3	428	384·7	187·6	488	438·6	213·9	548	492·5	240·2
309	277·7	135·5	369	331·7	161·8	429	385·6	188·1	489	439·5	214·4	549	493·4	240·7
310	278·6	135·9	370	332·6	162·2	430	386·5	188·5	490	440·4	214·8	550	494·3	241·1
311	279·5	136·3	371	333·5	162·6	431	387·4	188·9	491	441·3	215·2	551	495·2	241·5
312	280·4	136·8	372	334·4	163·1	432	388·3	189·4	492	442·2	215·7	552	496·1	242·0
313	281·3	137·2	373	335·3	163·5	433	389·2	189·8	493	443·1	216·1	553	497·0	242·4
314	282·2	137·7	374	336·2	164·0	434	390·1	190·3	494	444·0	216·6	554	497·9	242·9
315	283·1	138·1	375	337·1	164·4	435	391·0	190·7	495	444·9	217·0	555	498·8	243·3
316	284·0	138·5	376	338·0	164·8	436	391·9	191·1	496	445·8	217·4	556	499·7	243·7
317	284·9	139·0	377	338·9	165·3	437	392·8	191·6	497	446·7	217·9	557	500·6	244·2
318	285·8	139·4	378	339·8	165·7	438	393·7	192·0	498	447·6	218·3	558	501·5	244·6
319	286·7	139·8	379	340·7	166·2	439	394·6	192·4	499	448·5	218·7	559	502·4	245·0
320	287·6	140·3	380	341·5	166·6	440	395·5	192·9	500	449·4	219·2	560	503·3	245·5
321	288·5	140·7	381	342·4	167·0	441	396·4	193·3	501	450·3	219·6	561	504·2	245·9
322	289·4	141·2	382	343·3	167·5	442	397·3	193·8	502	451·2	220·1	562	505·1	246·4
323	290·3	141·6	383	344·2	167·9	443	398·2	194·2	503	452·1	220·5	563	506·0	246·8
324	291·2	142·0	384	345·1	168·3	444	399·1	194·7	504	453·0	221·0	564	506·9	247·3
325	292·1	142·5	385	346·0	168·8	445	400·0	195·1	505	453·9	221·4	565	507·8	247·7
326	293·0	142·9	386	346·9	169·2	446	400·9	195·5	506	454·8	221·8	566	508·7	248·1
327	293·9	143·4	387	347·8	169·7	447	401·8	196·0	507	455·7	222·3	567	509·6	248·6
328	294·8	143·8	388	348·7	170·1	448	402·7	196·4	508	456·6	222·7	568	510·5	249·0
329	295·7	144·2	389	349·6	170·5	449	403·6	196·8	509	457·5	223·1	569	511·4	249·4
330	296·6	144·7	390	350·5	171·0	450	404·5	197·3	510	458·4	223·6	570	512·3	249·9
331	297·5	145·1	391	351·4	171·4	451	405·4	197·7	511	459·3	224·0	571	513·2	250·3
332	298·4	145·6	392	352·3	171·8	452	406·3	198·1	512	460·2	224·4	572	514·1	250·8
333	299·3	146·0	393	353·2	172·3	453	407·2	198·6	513	461·1	224·9	573	515·0	251·2
334	300·2	146·4	394	354·1	172·7	454	408·1	199·0	514	462·0	225·3	574	515·9	251·6
335	301·1	146·9	395	355·0	173·2	455	409·0	199·5	515	462·9	225·8	575	516·8	252·1
336	302·0	147·3	396	355·9	173·6	456	409·9	199·9	516	463·8	226·2	576	517·7	252·5
337	302·9	147·7	397	356·8	174·0	457	410·8	200·3	517	464·7	226·6	577	518·6	252·9
338	303·8	148·2	398	357·7	174·5	458	411·7	200·8	518	465·6	227·1	578	519·5	253·4
339	304·7	148·6	399	358·6	174·9	459	412·6	201·2	519	466·5	227·5	579	520·4	253·8
340	305·6	149·0	400	359·5	175·4	460	413·5	201·7	520	467·4	228·0	580	521·3	254·3
341	306·5	149·5	401	360·4	175·8	461	414·4	202·1	521	468·3	228·4	581	522·2	254·7
342	307·4	149·9	402	361·3	176·2	462	415·2	202·5	522	469·2	228·8	582	523·1	255·1
343	308·3	150·4	403	362·2	176·7	463	416·1	203·0	523	470·1	229·3	583	524·0	255·6
344	309·2	150·8	404	363·1	177·1	464	417·0	203·4	524	471·0	229·7	584	524·9	256·0
345	310·1	151·2	405	364·0	177·5	465	417·9	203·8	525	471·9	230·1	585	525·8	256·4
346	311·0	151·7	406	364·9	178·0	466	418·8	204·3	526	472·8	230·6	586	526·7	256·9
347	311·9	152·1	407	365·8	178·4	467	419·7	204·7	527	473·7	231·0	587	527·6	257·3
348	312·8	152·6	408	366·7	178·9	468	420·6	205·2	528	474·6	231·5	588	528·5	257·8
349	313·7	153·0	409	367·6	179·3	469	421·5	205·6	529	475·5	231·9	589	529·4	258·2
350	314·6	153·4	410	368·5	179·7	470	422·4	206·0	530	476·4	232·3	590	530·3	258·6
351	315·5	153·9	411	369·4	180·2	471	423·3	206·5	531	477·3	232·8	591	531·2	259·1
352	316·4	154·3	412	370·3	180·6	472	424·2	206·9	532	478·2	233·2	592	532·1	259·5
353	317·3	154·7	413	371·2	181·1	473	425·1	207·3	533	479·1	233·6	593	533·0	259·9
354	318·2	155·2	414	372·1	181·5	474	426·0	207·8	534	480·0	234·1	594	533·9	260·4
355	319·1	155·6	415	373·0	181·9	475	426·9	208·2	535	480·9	234·5	595	534·8	260·8
356	320·0	156·1	416	373·9	182·4	476	427·8	208·7	536	481·8	235·0	596	535·7	261·3
357	320·9	156·5	417	374·8	182·8	477	428·7	209·1	537	482·7	235·4	597	536·6	261·7
358	321·8	156·9	418	375·7	183·2	478	429·6	209·5	538	483·6	235·8	598	537·5	262·1
359	322·7	157·4	419	376·6	183·7	479	430·5	210·0	539	484·5	236·3	599	538·4	262·6
360	323·6	157·8	420	377·5	184·1	480	431·4	210·4	540	485·3	236·7	600	539·3	263·0
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

64° 4h 16m

TRAVERSE TABLE TO DEGREES

27° — 1h 48m

Dist.	D.Lat	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0.9	0.5	61	54.4	27.7	121	107.8	54.9	181	161.3	82.2	241	214.7	109.4
2	1.8	0.9	62	55.2	28.1	122	108.7	55.4	182	162.2	82.6	242	215.6	109.9
3	2.7	1.4	63	56.1	28.6	123	109.6	55.8	183	163.1	83.1	243	216.5	110.3
4	3.6	1.8	64	57.0	29.1	124	110.5	56.3	184	163.9	83.5	244	217.4	110.8
5	4.5	2.3	65	57.9	29.5	125	111.4	56.7	185	164.8	84.0	245	218.3	111.2
6	5.3	2.7	66	58.8	30.0	126	112.3	57.2	186	165.7	84.4	246	219.2	111.7
7	6.2	3.2	67	59.7	30.4	127	113.2	57.7	187	166.6	84.9	247	220.1	112.1
8	7.1	3.6	68	60.6	30.9	128	114.0	58.1	188	167.5	85.4	248	221.0	112.6
9	8.0	4.1	69	61.5	31.3	129	114.9	58.6	189	168.4	85.8	249	221.9	113.0
10	8.9	4.5	70	62.4	31.8	130	115.8	59.0	190	169.3	86.3	250	222.8	113.5
11	9.8	5.0	71	63.3	32.2	131	116.7	59.5	191	170.2	86.7	251	223.6	114.0
12	10.7	5.4	72	64.2	32.7	132	117.6	59.9	192	171.1	87.2	252	224.5	114.4
13	11.6	5.9	73	65.0	33.1	133	118.5	60.4	193	172.0	87.6	253	225.4	114.9
14	12.5	6.4	74	65.9	33.6	134	119.4	60.8	194	172.9	88.1	254	226.3	115.3
15	13.4	6.8	75	66.8	34.0	135	120.3	61.3	195	173.7	88.5	255	227.2	115.8
16	14.3	7.3	76	67.7	34.5	136	121.2	61.7	196	174.6	89.0	256	228.1	116.2
17	15.1	7.7	77	68.6	35.0	137	122.1	62.2	197	175.5	89.4	257	229.0	116.7
18	16.0	8.2	78	69.5	35.4	138	123.0	62.7	198	176.4	89.9	258	229.9	117.1
19	16.9	8.6	79	70.4	35.9	139	123.8	63.1	199	177.3	90.3	259	230.8	117.6
20	17.8	9.1	80	71.3	36.3	140	124.7	63.6	200	178.2	90.8	260	231.7	118.0
21	18.7	9.5	81	72.2	36.8	141	125.6	64.0	201	179.1	91.3	261	232.6	118.5
22	19.6	10.0	82	73.1	37.2	142	126.5	64.5	202	180.0	91.7	262	233.4	118.9
23	20.5	10.4	83	74.0	37.7	143	127.4	64.9	203	180.9	92.2	263	234.3	119.4
24	21.4	10.9	84	74.8	38.1	144	128.3	65.4	204	181.8	92.6	264	235.2	119.9
25	22.3	11.3	85	75.7	38.6	145	129.2	65.8	205	182.7	93.1	265	236.1	120.3
26	23.2	11.8	86	76.6	39.0	146	130.1	66.3	206	183.5	93.5	266	237.0	120.8
27	24.1	12.3	87	77.5	39.5	147	131.0	66.7	207	184.4	94.0	267	237.9	121.2
28	24.9	12.7	88	78.4	40.0	148	131.9	67.2	208	185.3	94.4	268	238.8	121.7
29	25.8	13.2	89	79.3	40.4	149	132.8	67.6	209	186.2	94.9	269	239.7	122.1
30	26.7	13.6	90	80.2	40.9	150	133.7	68.1	210	187.1	95.3	270	240.6	122.6
31	27.6	14.1	91	81.1	41.3	151	134.5	68.6	211	188.0	95.8	271	241.5	123.0
32	28.5	14.5	92	82.0	41.8	152	135.4	69.0	212	188.9	96.2	272	242.4	123.5
33	29.4	15.0	93	82.9	42.2	153	136.3	69.5	213	189.8	96.7	273	243.2	123.9
34	30.3	15.4	94	83.8	42.7	154	137.2	69.9	214	190.7	97.2	274	244.1	124.4
35	31.2	15.9	95	84.6	43.1	155	138.1	70.4	215	191.6	97.6	275	245.0	124.8
36	32.1	16.3	96	85.5	43.6	156	139.0	70.8	216	192.5	98.1	276	245.9	125.3
37	33.0	16.8	97	86.4	44.0	157	139.9	71.3	217	193.3	98.5	277	246.8	125.8
38	33.9	17.3	98	87.3	44.5	158	140.8	71.7	218	194.2	99.0	278	247.7	126.2
39	34.7	17.7	99	88.2	44.9	159	141.7	72.2	219	195.1	99.4	279	248.6	126.7
40	35.6	18.2	100	89.1	45.4	160	142.6	72.6	220	196.0	99.9	280	249.5	127.1
41	36.5	18.6	101	90.0	45.9	161	143.5	73.1	221	196.9	100.3	281	250.4	127.6
42	37.4	19.1	102	90.9	46.3	162	144.3	73.5	222	197.8	100.8	282	251.3	128.0
43	38.3	19.5	103	91.8	46.8	163	145.2	74.0	223	198.7	101.2	283	252.2	128.5
44	39.2	20.0	104	92.7	47.2	164	146.1	74.5	224	199.6	101.7	284	253.0	128.9
45	40.1	20.4	105	93.6	47.7	165	147.0	74.9	225	200.5	102.1	285	253.9	129.4
46	41.0	20.9	106	94.4	48.1	166	147.9	75.4	226	201.4	102.6	286	254.8	129.8
47	41.9	21.3	107	95.3	48.6	167	148.8	75.8	227	202.3	103.1	287	255.7	130.3
48	42.8	21.8	108	96.2	49.0	168	149.7	76.3	228	203.1	103.5	288	256.6	130.7
49	43.7	22.2	109	97.1	49.5	169	150.6	76.7	229	204.0	104.0	289	257.5	131.2
50	44.6	22.7	110	98.0	49.9	170	151.5	77.2	230	204.9	104.4	290	258.4	131.7
51	45.4	23.2	111	98.9	50.4	171	152.4	77.6	231	205.8	104.9	291	259.3	132.1
52	46.3	23.6	112	99.8	50.8	172	153.3	78.1	232	206.7	105.3	292	260.2	132.6
53	47.2	24.1	113	100.7	51.3	173	154.1	78.5	233	207.6	105.8	293	261.1	133.0
54	48.1	24.5	114	101.6	51.8	174	155.0	79.0	234	208.5	106.2	294	262.0	133.5
55	49.0	25.0	115	102.5	52.2	175	155.9	79.4	235	209.4	106.7	295	262.8	133.9
56	49.9	25.4	116	103.4	52.7	176	156.8	79.9	236	210.3	107.1	296	263.7	134.4
57	50.8	25.9	117	104.2	53.1	177	157.7	80.4	237	211.2	107.6	297	264.6	134.8
58	51.7	26.3	118	105.1	53.6	178	158.6	80.8	238	212.1	108.0	298	265.5	135.3
59	52.6	26.8	119	106.0	54.0	179	159.5	81.3	239	213.0	108.5	299	266.4	135.7
60	53.5	27.2	120	106.9	54.5	180	160.4	81.7	240	213.8	109.0	300	267.3	136.2
Dist.	Dep.	D.Lat	Dist.	Dep.	D.Lat	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

63° — 4h 12m

TRAVERSE TABLE TO DEGREES

27° 1h 48m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	268·2	136·7	361	321·7	163·9	421	375·1	191·1	481	428·6	218·3	541	482·0	245·6
302	269·1	137·1	362	322·5	164·4	422	376·0	191·6	482	429·4	218·8	542	482·9	246·1
303	270·0	137·6	363	323·4	164·8	423	376·9	192·0	483	430·3	219·2	543	483·8	246·5
304	270·9	138·0	364	324·3	165·3	424	377·8	192·5	484	431·2	219·7	544	484·7	247·0
305	271·8	138·5	365	325·2	165·7	425	378·7	193·0	485	432·1	220·1	545	485·6	247·4
306	272·7	138·9	366	326·1	166·2	426	379·6	193·4	486	433·0	220·6	546	486·4	247·9
307	273·5	139·4	367	327·0	166·6	427	380·5	193·9	487	433·9	221·1	547	487·3	248·4
308	274·4	139·8	368	327·9	167·1	428	381·4	194·3	488	434·8	221·5	548	488·2	248·8
309	275·3	140·3	369	328·8	167·5	429	382·2	194·8	489	435·7	222·0	549	489·1	249·2
310	276·2	140·7	370	329·7	168·0	430	383·1	195·2	490	436·6	222·4	550	490·0	249·7
311	277·1	141·2	371	330·6	168·4	431	384·0	195·7	491	437·5	222·9	551	490·9	250·1
312	278·0	141·7	372	331·5	168·9	432	384·9	196·1	492	438·3	223·3	552	491·8	250·6
313	278·9	142·1	373	332·3	169·3	433	385·8	196·6	493	439·2	223·8	553	492·7	251·0
314	279·8	142·6	374	333·2	169·8	434	386·7	197·0	494	440·1	224·2	554	493·6	251·5
315	280·7	143·0	375	334·1	170·3	435	387·6	197·5	495	441·0	224·7	555	494·5	252·0
316	281·6	143·5	376	335·0	170·7	436	388·5	197·9	496	441·9	225·2	556	495·4	252·4
317	282·5	143·9	377	335·9	171·2	437	389·4	198·4	497	442·8	225·6	557	496·3	252·9
318	283·3	144·4	378	336·8	171·6	438	390·3	198·9	498	443·7	226·1	558	497·2	253·3
319	284·2	144·8	379	337·7	172·1	439	391·2	199·3	499	444·6	226·5	559	498·1	253·8
320	285·1	145·3	380	338·6	172·5	440	392·0	199·8	500	445·5	227·0	560	499·0	254·2
321	286·0	145·7	381	339·5	173·0	441	392·9	200·2	501	446·4	227·5	561	499·8	254·7
322	286·9	146·2	382	340·4	173·4	442	393·8	200·7	502	447·3	227·9	562	500·7	255·1
323	287·8	146·6	383	341·3	173·9	443	394·7	201·1	503	448·2	228·4	563	501·6	255·6
324	288·7	147·1	384	342·1	174·3	444	395·6	201·6	504	449·0	228·8	564	502·5	256·0
325	289·6	147·6	385	343·0	174·8	445	396·5	202·0	505	449·9	229·3	565	503·4	256·5
326	290·5	148·0	386	343·9	175·2	446	397·4	202·5	506	450·8	229·8	566	504·3	257·0
327	291·4	148·5	387	344·8	175·7	447	398·3	202·9	507	451·7	230·2	567	505·2	257·4
328	292·3	148·9	388	345·7	176·2	448	399·2	203·4	508	452·6	230·6	568	506·1	257·9
329	293·2	149·4	389	346·6	176·6	449	400·1	203·8	509	453·5	231·0	569	507·0	258·3
330	294·0	149·8	390	347·5	177·1	450	401·0	204·3	510	454·4	231·5	570	507·9	258·8
331	294·9	150·3	391	348·4	177·5	451	401·8	204·7	511	455·3	231·9	571	508·7	259·2
332	295·8	150·7	392	349·3	178·0	452	402·7	205·2	512	456·2	232·4	572	509·6	259·7
333	296·7	151·2	393	350·2	178·4	453	403·6	205·7	513	457·1	232·9	573	510·5	260·1
334	297·6	151·6	394	351·1	178·9	454	404·5	206·1	514	458·0	233·3	574	511·4	260·6
335	298·5	152·1	395	352·0	179·3	455	405·4	206·6	515	458·8	233·8	575	512·3	261·1
336	299·4	152·5	396	352·8	179·8	456	406·3	207·0	516	459·7	234·2	576	513·2	261·5
337	300·3	153·0	397	353·7	180·2	457	407·2	207·5	517	460·6	234·7	577	514·1	262·0
338	301·2	153·5	398	354·6	180·7	458	408·1	207·9	518	461·5	235·2	578	515·0	262·4
339	302·1	153·9	399	355·5	181·2	459	409·0	208·4	519	462·4	235·7	579	515·9	262·9
340	302·9	154·4	400	356·4	181·6	460	409·9	208·8	520	463·3	236·1	580	516·8	263·4
341	303·8	154·8	401	357·3	182·1	461	410·8	209·3	521	464·2	236·6	581	517·7	263·8
342	304·7	155·3	402	358·2	182·5	462	411·6	209·8	522	465·1	237·0	582	518·5	264·3
343	305·6	155·7	403	359·1	183·0	463	412·5	210·2	523	466·0	237·5	583	519·4	264·7
344	306·5	156·2	404	360·0	183·4	464	413·4	210·7	524	466·9	237·9	584	520·3	265·2
345	307·4	156·6	405	360·9	183·9	465	414·3	211·1	525	467·8	238·4	585	521·2	265·6
346	308·3	157·1	406	361·8	184·3	466	415·2	211·6	526	468·7	238·8	586	522·1	266·0
347	309·2	157·5	407	362·6	184·8	467	416·1	212·0	527	469·5	239·3	587	523·0	266·5
348	310·1	158·0	408	363·5	185·2	468	417·0	212·5	528	470·4	239·7	588	523·9	267·0
349	311·0	158·5	409	364·4	185·7	469	417·9	212·9	529	471·3	240·2	589	524·8	267·4
350	311·9	158·9	410	365·3	186·1	470	418·8	213·4	530	472·2	240·6	590	525·7	267·9
351	312·7	159·4	411	366·2	186·6	471	419·7	213·8	531	473·1	241·1	591	526·6	268·3
352	313·6	159·8	412	367·1	187·1	472	420·6	214·3	532	474·0	241·5	592	527·5	268·8
353	314·5	160·3	413	368·0	187·5	473	421·4	214·7	533	474·9	242·0	593	528·4	269·2
354	315·4	160·7	414	368·9	188·0	474	422·3	215·2	534	475·8	242·4	594	529·3	269·7
355	316·3	161·2	415	369·8	188·4	475	423·2	215·7	535	476·7	242·9	595	530·1	270·1
356	317·2	161·6	416	370·7	188·9	476	424·1	216·1	536	477·6	243·4	596	531·0	270·6
357	318·1	162·1	417	371·6	189·3	477	425·0	216·6	537	478·4	243·8	597	531·9	271·1
358	319·0	162·5	418	372·4	189·8	478	425·9	217·0	538	479·3	244·3	598	532·8	271·5
359	319·9	163·0	419	373·3	190·2	479	426·8	217·5	539	480·2	244·7	599	533·7	272·0
360	320·8	163·4	420	374·2	190·7	480	427·7	217·9	540	481·1	245·2	600	534·6	272·4
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

63° 4h 12m

TRAVERSE TABLE TO DEGREES

28° 1ʰ 52ᵐ

Dist.	D.Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·9	0·5	61	53·9	28·6	121	106·8	56·8	181	159·8	85·0	241	212·8	113·1
2	1·8	0·9	62	54·7	29·1	122	107·7	57·3	182	160·7	85·4	242	213·7	113·6
3	2·6	1·4	63	55·6	29·6	123	108·6	57·7	183	161·6	85·9	243	214·6	114·1
4	3·5	1·9	64	56·5	30·0	124	109·5	58·2	184	162·5	86·4	244	215·4	114·6
5	4·4	2·3	65	57·4	30·5	125	110·4	58·7	185	163·3	86·9	245	216·3	115·0
6	5·3	2·8	66	58·3	31·0	126	111·3	59·2	186	164·2	87·3	246	217·2	115·5
7	6·2	3·3	67	59·2	31·5	127	112·1	59·6	187	165·1	87·8	247	218·1	116·0
8	7·1	3·8	68	60·0	31·9	128	113·0	60·1	188	166·0	88·3	248	219·0	116·4
9	7·9	4·2	69	60·9	32·4	129	113·9	60·6	189	166·9	88·7	249	219·9	116·9
10	8·8	4·7	70	61·8	32·9	130	114·8	61·0	190	167·8	89·2	250	220·7	117·4
11	9·7	5·2	71	62·7	33·3	131	115·7	61·5	191	168·6	89·7	251	221·6	117·8
12	10·6	5·6	72	63·6	33·8	132	116·5	62·0	192	169·5	90·1	252	222·5	118·3
13	11·5	6·1	73	64·5	34·3	133	117·4	62·4	193	170·4	90·6	253	223·4	118·8
14	12·4	6·6	74	65·3	34·7	134	118·3	62·9	194	171·3	91·1	254	224·3	119·2
15	13·2	7·0	75	66·2	35·2	135	119·2	63·4	195	172·2	91·5	255	225·2	119·7
16	14·1	7·5	76	67·1	35·7	136	120·1	63·8	196	173·1	92·0	256	226·0	120·2
17	15·0	8·0	77	68·0	36·1	137	121·0	64·3	197	173·9	92·5	257	226·9	120·7
18	15·9	8·5	78	68·9	36·6	138	121·8	64·8	198	174·8	93·0	258	227·8	121·1
19	16·8	8·9	79	69·8	37·1	139	122·7	65·3	199	175·7	93·4	259	228·7	121·6
20	17·7	9·4	80	70·6	37·6	140	123·6	65·7	200	176·6	93·9	260	229·6	122·1
21	18·5	9·9	81	71·5	38·0	141	124·5	66·2	201	177·5	94·4	261	230·4	122·5
22	19·4	10·3	82	72·4	38·5	142	125·4	66·7	202	178·4	94·8	262	231·3	123·0
23	20·3	10·8	83	73·3	39·0	143	126·3	67·1	203	179·2	95·3	263	232·2	123·5
24	21·2	11·3	84	74·2	39·4	144	127·1	67·6	204	180·1	95·8	264	233·1	123·9
25	22·1	11·7	85	75·1	39·9	145	128·0	68·1	205	181·0	96·2	265	234·0	124·4
26	23·0	12·2	86	75·9	40·4	146	128·9	68·5	206	181·9	96·7	266	234·9	124·9
27	23·8	12·7	87	76·8	40·8	147	129·8	69·0	207	182·8	97·2	267	235·7	125·3
28	24·7	13·1	88	77·7	41·3	148	130·7	69·5	208	183·7	97·7	268	236·6	125·8
29	25·6	13·6	89	78·6	41·8	149	131·6	70·0	209	184·5	98·1	269	237·5	126·3
30	26·5	14·1	90	79·5	42·3	150	132·4	70·4	210	185·4	98·6	270	238·4	126·8
31	27·4	14·6	91	80·3	42·7	151	133·3	70·9	211	186·3	99·1	271	239·3	127·2
32	28·3	15·0	92	81·2	43·2	152	134·2	71·4	212	187·2	99·5	272	240·2	127·7
33	29·1	15·5	93	82·1	43·7	153	135·1	71·8	213	188·1	100·0	273	241·0	128·2
34	30·0	16·0	94	83·0	44·1	154	136·0	72·3	214	189·0	100·5	274	241·9	128·6
35	30·9	16·4	95	83·9	44·6	155	136·9	72·8	215	189·8	100·9	275	242·8	129·1
36	31·8	16·9	96	84·8	45·1	156	137·7	73·2	216	190·7	101·4	276	243·7	129·6
37	32·7	17·4	97	85·6	45·5	157	138·6	73·7	217	191·6	101·9	277	244·6	130·0
38	33·6	17·8	98	86·5	46·0	158	139·5	74·2	218	192·5	102·3	278	245·5	130·5
39	34·4	18·3	99	87·4	46·5	159	140·4	74·6	219	193·4	102·8	279	246·3	131·0
40	35·3	18·8	100	88·3	46·9	160	141·3	75·1	220	194·2	103·3	280	247·2	131·5
41	36·2	19·2	101	89·2	47·4	161	142·2	75·6	221	195·1	103·8	281	248·1	131·9
42	37·1	19·7	102	90·1	47·9	162	143·0	76·1	222	196·0	104·2	282	249·0	132·4
43	38·0	20·2	103	90·9	48·4	163	143·9	76·5	223	196·9	104·7	283	249·9	132·9
44	38·8	20·7	104	91·8	48·8	164	144·8	77·0	224	197·8	105·2	284	250·8	133·3
45	39·7	21·1	105	92·7	49·3	165	145·7	77·5	225	198·7	105·6	285	251·6	133·8
46	40·6	21·6	106	93·6	49·8	166	146·6	77·9	226	199·5	106·1	286	252·5	134·3
47	41·5	22·1	107	94·5	50·2	167	147·5	78·4	227	200·4	106·6	287	253·4	134·7
48	42·4	22·5	108	95·4	50·7	168	148·3	78·9	228	201·3	107·0	288	254·3	135·2
49	43·3	23·0	109	96·2	51·2	169	149·2	79·3	229	202·2	107·5	289	255·2	135·7
50	44·1	23·5	110	97·1	51·6	170	150·1	79·8	230	203·1	108·0	290	256·1	136·1
51	45·0	23·9	111	98·0	52·1	171	151·0	80·3	231	204·0	108·4	291	256·9	136·6
52	45·9	24·4	112	98·9	52·6	172	151·9	80·7	232	204·8	108·9	292	257·8	137·1
53	46·8	24·9	113	99·8	53·1	173	152·7	81·2	233	205·7	109·4	293	258·7	137·6
54	47·7	25·4	114	100·7	53·5	174	153·6	81·7	234	206·6	109·9	294	259·6	138·0
55	48·6	25·8	115	101·5	54·0	175	154·5	82·2	235	207·5	110·3	295	260·5	138·5
56	49·4	26·3	116	102·4	54·5	176	155·4	82·6	236	208·4	110·8	296	261·3	139·0
57	50·3	26·8	117	103·3	54·9	177	156·3	83·1	237	209·3	111·3	297	262·2	139·4
58	51·2	27·2	118	104·2	55·4	178	157·2	83·6	238	210·1	111·7	298	263·1	139·9
59	52·1	27·7	119	105·1	55·9	179	158·0	84·0	239	211·0	112·2	299	264·0	140·4
60	53·0	28·2	120	106·0	56·3	180	158·9	84·5	240	211·9	112·7	300	264·9	140·8
Dist.	Dep.	D.Lat.	Dist.	Dep.	D.Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

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TRAVERSE TABLE TO DEGREES

28° 1h 52m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	265·7	141·3	361	318·7	169·5	421	371·7	197·7	481	424·7	225·8	541	477·7	254·0
302	266·6	141·8	362	319·6	170·0	422	372·6	198·1	482	425·6	226·3	542	478·6	254·5
303	267·5	142·3	363	320·5	170·4	423	373·5	198·6	483	426·5	226·8	543	479·4	255·0
304	268·4	142·7	364	321·4	170·9	424	374·3	199·1	484	427·4	227·3	544	480·3	255·5
305	269·3	143·2	365	322·2	171·4	425	375·2	199·5	485	428·3	227·7	545	481·1	255·9
306	270·2	143·7	366	323·1	171·8	426	376·1	200·0	486	429·2	228·2	546	482·0	256·4
307	271·0	144·1	367	324·0	172·3	427	377·0	200·5	487	430·1	228·6	547	482·9	256·9
308	271·9	144·6	368	324·9	172·8	428	377·9	200·9	488	430·9	229·1	548	483·8	257·3
309	272·8	145·1	369	325·8	173·2	429	378·8	201·4	489	431·8	229·6	549	484·7	257·8
310	273·7	145·5	370	326·7	173·7	430	379·6	201·9	490	432·6	230·0	550	485·6	258·2
311	274·6	146·0	371	327·5	174·2	431	380·5	202·3	491	433·5	230·5	551	486·5	258·7
312	275·5	146·5	372	328·4	174·6	432	381·4	202·8	492	434·4	231·0	552	487·4	259·1
313	276·3	146·9	373	329·3	175·1	433	382·3	203·3	493	435·3	231·4	553	488·3	259·6
314	277·2	147·4	374	330·2	175·6	434	383·2	203·8	494	436·2	231·9	554	489·2	260·1
315	278·1	147·9	375	331·1	176·1	435	384·1	204·2	495	437·1	232·4	555	490·1	260·6
316	279·0	148·4	376	332·0	176·5	436	384·9	204·7	496	437·9	232·9	556	490·9	261·0
317	279·9	148·8	377	332·8	177·0	437	385·8	205·2	497	438·8	233·4	557	491·8	261·5
318	280·7	149·3	378	333·7	177·5	438	386·7	205·6	498	439·7	233·8	558	492·7	262·0
319	281·6	149·8	379	334·6	177·9	439	387·6	206·1	499	440·6	234·3	559	493·5	262·5
320	282·5	150·2	380	335·5	178·4	440	388·5	206·6	500	441·5	234·7	560	494·4	262·9
321	283·4	150·7	381	336·4	178·9	441	389·4	207·0	501	442·3	235·2	561	495·3	263·4
322	284·3	151·2	382	337·3	179·3	442	390·2	207·5	502	443·2	235·6	562	496·2	263·8
323	285·2	151·6	383	338·1	179·8	443	391·1	208·0	503	444·1	236·1	563	497·1	264·3
324	286·0	152·1	384	339·0	180·3	444	392·0	208·4	504	445·0	236·6	564	498·0	264·7
325	286·9	152·6	385	339·9	180·8	445	392·9	208·9	505	445·9	237·1	565	498·9	265·2
326	287·8	153·1	386	340·8	181·2	446	393·8	209·4	506	446·8	237·5	566	499·8	265·7
327	288·7	153·5	387	341·7	181·7	447	394·6	209·9	507	447·6	238·0	567	500·7	266·2
328	289·6	154·0	388	342·6	182·2	448	395·5	210·3	508	448·5	238·5	568	501·6	266·6
329	290·5	154·5	389	343·4	182·6	449	396·4	210·8	509	449·4	239·0	569	502·4	267·1
330	291·3	154·9	390	344·3	183·1	450	397·3	211·3	510	450·3	239·4	570	503·3	267·6
331	292·2	155·4	391	345·2	183·6	451	398·2	211·7	511	451·2	239·9	571	504·2	268·0
332	293·1	155·9	392	346·1	184·0	452	399·1	212·2	512	452·1	240·4	572	505·1	268·5
333	294·0	156·3	393	347·0	184·5	453	399·9	212·7	513	452·9	240·8	573	505·9	269·0
334	294·9	156·8	394	347·9	185·0	454	400·8	213·1	514	453·8	241·3	574	506·8	269·4
335	295·8	157·3	395	348·7	185·4	455	401·7	213·6	515	454·7	241·8	575	507·7	269·9
336	296·6	157·7	396	349·6	185·9	456	402·6	214·1	516	455·6	242·2	576	508·6	270·4
337	297·5	158·2	397	350·5	186·4	457	403·5	214·6	517	456·4	242·7	577	509·4	270·9
338	298·4	158·7	398	351·4	186·9	458	404·4	215·0	518	457·3	243·2	578	510·3	271·3
339	299·3	159·2	399	352·3	187·3	459	405·2	215·5	519	458·2	243·7	579	511·2	271·8
340	300·2	159·6	400	353·1	187·8	460	406·1	216·0	520	459·1	244·1	580	512·1	272·3
341	301·0	160·1	401	354·0	188·3	461	407·0	216·4	521	460·0	244·6	581	513·0	272·7
342	301·9	160·6	402	354·9	188·7	462	407·9	216·9	522	460·9	245·0	582	513·9	273·2
343	302·8	161·0	403	355·8	189·2	463	408·8	217·4	523	461·8	245·5	583	514·8	273·7
344	303·7	161·5	404	356·7	189·7	464	409·7	217·8	524	462·7	246·0	584	515·7	274·2
345	304·6	162·0	405	357·6	190·1	465	410·5	218·3	525	463·5	246·5	585	516·5	274·7
346	305·5	162·4	406	358·4	190·6	466	411·4	218·8	526	464·4	246·9	586	517·4	275·1
347	306·4	162·9	407	359·3	191·1	467	412·3	219·2	527	465·3	247·4	587	518·3	275·5
348	307·2	163·4	408	360·2	191·5	468	413·2	219·7	528	466·2	247·9	588	519·2	276·0
349	308·1	163·8	409	361·1	192·0	469	414·1	220·2	529	467·1	248·3	589	520·1	276·5
350	309·0	164·3	410	362·0	192·5	470	415·0	220·7	530	468·0	248·8	590	521·0	277·0
351	309·9	164·8	411	362·9	193·0	471	415·8	221·1	531	468·9	249·3	591	521·8	277·4
352	310·8	165·3	412	363·7	193·4	472	416·7	221·6	532	469·8	249·8	592	522·6	277·9
353	311·7	165·7	413	364·6	193·9	473	417·6	222·1	533	470·7	250·2	593	523·5	278·4
354	312·5	166·2	414	365·5	194·4	474	418·5	222·5	534	471·5	250·7	594	524·4	278·8
355	313·4	166·7	415	366·4	194·8	475	419·4	223·0	535	472·4	251·1	595	525·3	279·3
356	314·3	167·1	416	367·3	195·3	476	420·3	223·5	536	473·3	251·6	596	526·2	279·8
357	315·2	167·6	417	368·2	195·8	477	421·1	223·9	537	474·2	252·1	597	527·1	280·3
358	316·1	168·1	418	369·0	196·2	478	422·0	224·4	538	475·1	252·6	598	528·0	280·8
359	316·9	168·5	419	369·9	196·7	479	422·9	224·9	539	476·0	253·1	599	528·9	281·3
360	317·8	169·0	420	370·8	197·2	480	423·8	225·3	540	476·8	253·6	600	529·8	281·7
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

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TRAVERSE TABLE TO DEGREES

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Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·9	0·5	61	53·4	29·6	121	105·8	58·7	181	158·3	87·8	241	210·8	116·8
2	1·7	1·0	62	54·2	30·1	122	106·7	59·1	182	159·2	88·2	242	211·7	117·3
3	2·6	1·5	63	55·1	30·5	123	107·6	59·6	183	160·1	88·7	243	212·5	117·8
4	3·5	1·9	64	56·0	31·0	124	108·5	60·1	184	160·9	89·2	244	213·4	118·3
5	4·4	2·4	65	56·9	31·5	125	109·3	60·6	185	161·8	89·7	245	214·3	118·8
6	5·2	2·9	66	57·7	32·0	126	110·2	61·1	186	162·7	90·2	246	215·2	119·3
7	6·1	3·4	67	58·6	32·5	127	111·1	61·6	187	163·6	90·7	247	216·0	119·7
8	7·0	3·9	68	59·5	33·0	128	112·0	62·1	188	164·4	91·1	248	216·9	120·2
9	7·9	4·4	69	60·3	33·5	129	112·8	62·5	189	165·3	91·6	249	217·8	120·7
10	8·7	4·8	70	61·2	33·9	130	113·7	63·0	190	166·2	92·1	250	218·7	121·2
11	9·6	5·3	71	62·1	34·4	131	114·6	63·5	191	167·1	92·6	251	219·5	121·7
12	10·5	5·8	72	63·0	34·9	132	115·4	64·0	192	167·9	93·1	252	220·4	122·2
13	11·4	6·3	73	63·8	35·4	133	116·3	64·5	193	168·8	93·6	253	221·3	122·7
14	12·2	6·8	74	64·7	35·9	134	117·2	65·0	194	169·7	94·1	254	222·2	123·1
15	13·1	7·3	75	65·6	36·4	135	118·1	65·4	195	170·6	94·5	255	223·0	123·6
16	14·0	7·8	76	66·5	36·8	136	118·9	65·9	196	171·4	95·0	256	223·9	124·1
17	14·9	8·2	77	67·3	37·3	137	119·8	66·4	197	172·3	95·5	257	224·8	124·6
18	15·7	8·7	78	68·2	37·8	138	120·7	66·9	198	173·2	96·0	258	225·7	125·1
19	16·6	9·2	79	69·1	38·3	139	121·6	67·4	199	174·0	96·5	259	226·5	125·6
20	17·5	9·7	80	70·0	38·8	140	122·4	67·9	200	174·9	97·0	260	227·4	126·1
21	18·4	10·2	81	70·8	39·3	141	123·3	68·4	201	175·8	97·4	261	228·3	126·5
22	19·2	10·7	82	71·7	39·8	142	124·2	68·8	202	176·7	97·9	262	229·2	127·0
23	20·1	11·2	83	72·6	40·2	143	125·1	69·3	203	177·5	98·4	263	230·0	127·5
24	21·0	11·6	84	73·5	40·7	144	125·9	69·8	204	178·4	98·9	264	230·9	128·0
25	21·9	12·1	85	74·3	41·2	145	126·8	70·3	205	179·3	99·4	265	231·8	128·5
26	22·7	12·6	86	75·2	41·7	146	127·7	70·8	206	180·2	99·9	266	232·6	129·0
27	23·6	13·1	87	76·1	42·2	147	128·6	71·3	207	181·0	100·4	267	233·5	129·4
28	24·5	13·6	88	77·0	42·7	148	129·4	71·8	208	181·9	100·8	268	234·4	129·9
29	25·4	14·1	89	77·8	43·1	149	130·3	72·2	209	182·8	101·3	269	235·3	130·4
30	26·2	14·5	90	78·7	43·6	150	131·2	72·7	210	183·7	101·8	270	236·1	130·9
31	27·1	15·0	91	79·6	44·1	151	132·1	73·2	211	184·5	102·3	271	237·0	131·4
32	28·0	15·5	92	80·5	44·6	152	132·9	73·7	212	185·4	102·8	272	237·9	131·9
33	28·9	16·0	93	81·3	45·1	153	133·8	74·2	213	186·3	103·3	273	238·8	132·4
34	29·7	16·5	94	82·2	45·6	154	134·7	74·7	214	187·2	103·7	274	239·6	132·8
35	30·6	17·0	95	83·1	46·1	155	135·6	75·1	215	188·0	104·2	275	240·5	133·3
36	31·5	17·5	96	84·0	46·5	156	136·4	75·6	216	188·9	104·7	276	241·4	133·8
37	32·4	17·9	97	84·8	47·0	157	137·3	76·1	217	189·8	105·2	277	242·3	134·3
38	33·2	18·4	98	85·7	47·5	158	138·2	76·6	218	190·7	105·7	278	243·1	134·8
39	34·1	18·9	99	86·6	48·0	159	139·1	77·1	219	191·5	106·2	279	244·0	135·3
40	35·0	19·4	100	87·5	48·5	160	139·9	77·6	220	192·4	106·7	280	244·9	135·7
41	35·9	19·9	101	88·3	49·0	161	140·8	78·1	221	193·3	107·1	281	245·8	136·2
42	36·7	20·4	102	89·2	49·5	162	141·7	78·5	222	194·2	107·6	282	246·6	136·7
43	37·6	20·8	103	90·1	49·9	163	142·6	79·0	223	195·0	108·1	283	247·5	137·2
44	38·5	21·3	104	91·0	50·4	164	143·4	79·5	224	195·9	108·6	284	248·4	137·7
45	39·4	21·8	105	91·8	50·9	165	144·3	80·0	225	196·8	109·1	285	249·3	138·2
46	40·2	22·3	106	92·7	51·4	166	145·2	80·5	226	197·7	109·6	286	250·1	138·7
47	41·1	22·8	107	93·6	51·9	167	146·1	81·0	227	198·5	110·1	287	251·0	139·1
48	42·0	23·3	108	94·5	52·4	168	146·9	81·4	228	199·4	110·5	288	251·9	139·6
49	42·9	23·8	109	95·3	52·8	169	147·8	81·9	229	200·3	111·0	289	252·8	140·1
50	43·7	24·2	110	96·2	53·3	170	148·7	82·4	230	201·2	111·5	290	253·6	140·6
51	44·6	24·7	111	97·1	53·8	171	149·6	82·9	231	202·0	112·0	291	254·5	141·1
52	45·5	25·2	112	98·0	54·3	172	150·4	83·4	232	202·9	112·5	292	255·4	141·6
53	46·4	25·7	113	98·8	54·8	173	151·3	83·9	233	203·8	113·0	293	256·3	142·0
54	47·2	26·2	114	99·7	55·3	174	152·2	84·4	234	204·7	113·4	294	257·1	142·5
55	48·1	26·7	115	100·6	55·8	175	153·1	84·8	235	205·5	113·9	295	258·0	143·0
56	49·0	27·1	116	101·5	56·2	176	153·9	85·3	236	206·4	114·4	296	258·9	143·5
57	49·9	27·6	117	102·3	56·7	177	154·8	85·8	237	207·3	114·9	297	259·8	144·0
58	50·7	28·1	118	103·2	57·2	178	155·7	86·3	238	208·2	115·4	298	260·6	144·5
59	51·6	28·6	119	104·1	57·7	179	156·6	86·8	239	209·0	115·9	299	261·5	145·0
60	52·5	29·1	120	105·0	58·2	180	157·4	87·3	240	209·9	116·4	300	262·4	145·4
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

61° 4h 4m

TRAVERSE TABLE TO DEGREES

29° 1h 56m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	263·2	145·9	361	315·7	175·0	421	368·2	204·1	481	420·7	233·2	541	473·2	262·3
302	264·1	146·4	362	316·6	175·5	422	369·1	204·6	482	421·5	233·7	542	474·0	262·8
303	265·0	146·9	363	317·5	176·0	423	369·9	205·1	483	422·4	234·2	543	474·9	263·2
304	265·9	147·4	364	318·3	176·5	424	370·8	205·6	484	423·3	234·6	544	475·8	263·7
305	266·7	147·9	365	319·2	177·0	425	371·7	206·0	485	424·2	235·1	545	476·6	264·2
306	267·6	148·4	366	320·1	177·4	426	372·6	206·5	486	425·0	235·6	546	477·5	264·7
307	268·5	148·8	367	321·0	177·9	427	373·4	207·0	487	425·9	236·1	547	478·4	265·2
308	269·4	149·3	368	321·8	178·4	428	374·3	207·5	488	426·8	236·6	548	479·3	265·7
309	270·2	149·8	369	322·7	178·9	429	375·2	208·0	489	427·7	237·1	549	480·1	266·2
310	271·1	150·3	370	323·6	179·4	430	376·1	208·5	490	428·5	237·6	550	481·0	266·6
311	272·0	150·8	371	324·5	179·9	431	376·9	209·0	491	429·4	238·0	551	481·9	267·1
312	272·9	151·3	372	325·3	180·4	432	377·8	209·4	492	430·3	238·5	552	482·8	267·6
313	273·7	151·7	373	326·2	180·8	433	378·7	209·9	493	431·2	239·0	553	483·6	268·1
314	274·6	152·2	374	327·1	181·3	434	379·6	210·4	494	432·0	239·5	554	484·5	268·6
315	275·5	152·7	375	328·0	181·8	435	380·4	210·9	495	432·9	240·0	555	485·4	269·1
316	276·3	153·2	376	328·8	182·3	436	381·3	211·4	496	433·8	240·5	556	486·3	269·5
317	277·2	153·7	377	329·7	182·8	437	382·2	211·9	497	434·7	240·9	557	487·1	270·0
318	278·1	154·2	378	330·6	183·3	438	383·1	212·3	498	435·5	241·4	558	488·0	270·5
319	279·0	154·7	379	331·4	183·7	439	383·9	212·8	499	436·4	241·9	559	488·9	271·0
320	279·8	155·1	380	332·3	184·2	440	384·8	213·3	500	437·3	242·4	560	489·8	271·5
321	280·7	155·6	381	333·2	184·7	441	385·7	213·8	501	438·2	242·9	561	490·6	272·0
322	281·6	156·1	382	334·1	185·2	442	386·6	214·3	502	439·0	243·4	562	491·5	272·5
323	282·5	156·6	383	334·9	185·7	443	387·4	214·8	503	439·9	243·9	563	492·4	272·9
324	283·3	157·1	384	335·8	186·2	444	388·3	215·3	504	440·8	244·3	564	493·2	273·4
325	284·2	157·6	385	336·7	186·7	445	389·2	215·7	505	441·6	244·8	565	494·1	273·9
326	285·1	158·1	386	337·6	187·1	446	390·0	216·2	506	442·5	245·3	566	495·0	274·4
327	286·0	158·5	387	338·4	187·6	447	390·9	216·7	507	443·4	245·8	567	495·9	274·9
328	286·8	159·0	388	339·3	188·1	448	391·8	217·2	508	444·3	246·3	568	496·8	275·4
329	287·7	159·5	389	340·2	188·6	449	392·7	217·7	509	445·2	246·8	569	497·7	275·9
330	288·6	160·0	390	341·1	189·1	450	393·5	218·2	510	446·1	247·3	570	498·5	276·3
331	289·5	160·5	391	341·9	189·6	451	394·4	218·7	511	447·0	247·8	571	499·4	276·8
332	290·3	161·0	392	342·8	190·0	452	395·3	219·1	512	447·8	248·2	572	500·3	277·3
333	291·2	161·4	393	343·7	190·5	453	396·2	219·6	513	448·6	248·7	573	501·1	277·8
334	292·1	161·9	394	344·6	191·0	454	397·0	220·1	514	449·5	249·2	574	502·0	278·3
335	293·0	162·4	395	345·4	191·5	455	397·9	220·6	515	450·4	249·7	575	502·9	278·8
336	293·8	162·9	396	346·3	192·0	456	398·8	221·1	516	451·3	250·2	576	503·7	279·2
337	294·7	163·4	397	347·2	192·5	457	399·7	221·6	517	452·2	250·6	577	504·6	279·7
338	295·6	163·9	398	348·1	193·0	458	400·5	222·0	518	453·1	251·1	578	505·5	280·2
339	296·5	164·4	399	348·9	193·4	459	401·4	222·5	519	453·9	251·6	579	506·4	280·7
340	297·3	164·8	400	349·8	193·9	460	402·3	223·0	520	454·8	252·1	580	507·2	281·2
341	298·2	165·3	401	350·7	194·4	461	403·2	223·5	521	455·6	252·6	581	508·1	281·7
342	299·1	165·8	402	351·6	194·9	462	404·0	224·0	522	456·5	253·1	582	509·0	282·2
343	300·0	166·3	403	352·4	195·4	463	404·9	224·5	523	457·4	253·6	583	509·9	282·7
344	300·8	166·8	404	353·3	195·9	464	405·8	225·0	524	458·3	254·0	584	510·7	283·2
345	301·7	167·3	405	354·2	196·3	465	406·7	225·4	525	459·1	254·5	585	511·6	283·6
346	302·6	167·7	406	355·1	196·8	466	407·5	225·9	526	460·0	255·0	586	512·5	284·1
347	303·5	168·2	407	355·9	197·3	467	408·4	226·4	527	460·9	255·5	587	513·4	284·6
348	304·3	168·7	408	356·8	197·8	468	409·3	226·9	528	461·8	256·0	588	514·3	285·0
349	305·2	169·2	409	357·7	198·3	469	410·2	227·4	529	462·6	256·5	589	515·1	285·5
350	306·1	169·7	410	358·6	198·8	470	411·0	227·9	530	463·5	256·9	590	516·0	286·0
351	307·0	170·2	411	359·4	199·3	471	411·9	228·3	531	464·4	257·4	591	516·9	286·5
352	307·8	170·7	412	360·3	199·7	472	412·8	228·8	532	465·3	257·9	592	517·7	287·0
353	308·7	171·1	413	361·2	200·2	473	413·7	229·3	533	466·1	258·4	593	518·6	287·5
354	309·6	171·6	414	362·1	200·7	474	414·5	229·8	534	467·0	258·9	594	519·5	288·0
355	310·5	172·1	415	362·9	201·2	475	415·4	230·3	535	467·9	259·4	595	520·4	288·5
356	311·3	172·6	416	363·8	201·7	476	416·3	230·8	536	468·8	259·9	596	521·2	288·9
357	312·2	173·1	417	364·7	202·2	477	417·2	231·3	537	469·6	260·3	597	522·1	289·4
358	313·1	173·6	418	365·6	202·7	478	418·0	231·7	538	470·5	260·8	598	523·0	289·9
359	314·0	174·0	419	366·4	203·1	479	418·9	232·2	539	471·4	261·3	599	523·9	290·4
360	314·8	174·5	420	367·3	203·6	480	419·8	232·7	540	472·3	261·8	600	524·8	290·9
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

61° 4h 4m

TRAVERSE TABLE TO DEGREES

30° — $2^h\ 0^m$

Dist.	D.Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·9	0·5	61	52·8	30·5	121	104·8	60·5	181	156·8	90·5	241	208·7	120·5
2	1·7	1·0	62	53·7	31·0	122	105·7	61·0	182	157·6	91·0	242	209·6	121·0
3	2·6	1·5	63	54·6	31·5	123	106·5	61·5	183	158·5	91·5	243	210·4	121·5
4	3·5	2·0	64	55·4	32·0	124	107·4	62·0	184	159·3	92·0	244	211·3	122·0
5	4·3	2·5	65	56·3	32·5	125	108·3	62·5	185	160·2	92·5	245	212·2	122·5
6	5·2	3·0	66	57·2	33·0	126	109·1	63·0	186	161·1	93·0	246	213·0	123·0
7	6·1	3·5	67	58·0	33·5	127	110·0	63·5	187	161·9	93·5	247	213·9	123·5
8	6·9	4·0	68	58·9	34·0	128	110·9	64·0	188	162·8	94·0	248	214·8	124·0
9	7·8	4·5	69	59·8	34·5	129	111·7	64·5	189	163·7	94·5	249	215·6	124·5
10	8·7	5·0	70	60·6	35·0	130	112·6	65·0	190	164·5	95·0	250	216·5	125·0
11	9·5	5·5	71	61·5	35·5	131	113·4	65·5	191	165·4	95·5	251	217·4	125·5
12	10·4	6·0	72	62·4	36·0	132	114·3	66·0	192	166·3	96·0	252	218·2	126·0
13	11·3	6·5	73	63·2	36·5	133	115·2	66·5	193	167·1	96·5	253	219·1	126·5
14	12·1	7·0	74	64·1	37·0	134	116·0	67·0	194	168·0	97·0	254	220·0	127·0
15	13·0	7·5	75	65·0	37·5	135	116·9	67·5	195	168·9	97·5	255	220·8	127·5
16	13·9	8·0	76	65·8	38·0	136	117·8	68·0	196	169·7	98·0	256	221·7	128·0
17	14·7	8·5	77	66·7	38·5	137	118·6	68·5	197	170·6	98·5	257	222·6	128·5
18	15·6	9·0	78	67·5	39·0	138	119·5	69·0	198	171·5	99·0	258	223·4	129·0
19	16·5	9·5	79	68·4	39·5	139	120·4	69·5	199	172·3	99·5	259	224·3	129·5
20	17·3	10·0	80	69·3	40·0	140	121·2	70·0	200	173·2	100·0	260	225·2	130·0
21	18·2	10·5	81	70·1	40·5	141	122·1	70·5	201	174·1	100·5	261	226·0	130·5
22	19·1	11·0	82	71·0	41·0	142	123·0	71·0	202	174·9	101·0	262	226·9	131·0
23	19·9	11·5	83	71·9	41·5	143	123·8	71·5	203	175·8	101·5	263	227·8	131·5
24	20·8	12·0	84	72·7	42·0	144	124·7	72·0	204	176·7	102·0	264	228·6	132·0
25	21·7	12·5	85	73·6	42·5	145	125·6	72·5	205	177·5	102·5	265	229·5	132·5
26	22·5	13·0	86	74·5	43·0	146	126·4	73·0	206	178·4	103·0	266	230·4	133·0
27	23·4	13·5	87	75·3	43·5	147	127·3	73·5	207	179·3	103·5	267	231·2	133·5
28	24·2	14·0	88	76·2	44·0	148	128·2	74·0	208	180·1	104·0	268	232·1	134·0
29	25·1	14·5	89	77·1	44·5	149	129·0	74·5	209	181·0	104·5	269	233·0	134·5
30	26·0	15·0	90	77·9	45·0	150	129·9	75·0	210	181·9	105·0	270	233·8	135·0
31	26·8	15·5	91	78·8	45·5	151	130·8	75·5	211	182·7	105·5	271	234·7	135·5
32	27·7	16·0	92	79·7	46·0	152	131·6	76·0	212	183·6	106·0	272	235·6	136·0
33	28·6	16·5	93	80·5	46·5	153	132·5	76·5	213	184·5	106·5	273	236·4	136·5
34	29·4	17·0	94	81·4	47·0	154	133·4	77·0	214	185·3	107·0	274	237·3	137·0
35	30·3	17·5	95	82·3	47·5	155	134·2	77·5	215	186·2	107·5	275	238·2	137·5
36	31·2	18·0	96	83·1	48·0	156	135·1	78·0	216	187·1	108·0	276	239·0	138·0
37	32·0	18·5	97	84·0	48·5	157	136·0	78·5	217	187·9	108·5	277	239·9	138·5
38	32·9	19·0	98	84·9	49·0	158	136·8	79·0	218	188·8	109·0	278	240·8	139·0
39	33·8	19·5	99	85·7	49·5	159	137·7	79·5	219	189·7	109·5	279	241·6	139·5
40	34·6	20·0	100	86·6	50·0	160	138·6	80·0	220	190·5	110·0	280	242·5	140·0
41	35·5	20·5	101	87·5	50·5	161	139·4	80·5	221	191·4	110·5	281	243·4	140·5
42	36·4	21·0	102	88·3	51·0	162	140·3	81·0	222	192·3	111·0	282	244·2	141·0
43	37·2	21·5	103	89·2	51·5	163	141·2	81·5	223	193·1	111·5	283	245·1	141·5
44	38·1	22·0	104	90·1	52·0	164	142·0	82·0	224	194·0	112·0	284	246·0	142·0
45	39·0	22·5	105	90·9	52·5	165	142·9	82·5	225	194·9	112·5	285	246·8	142·5
46	39·8	23·0	106	91·8	53·0	166	143·8	83·0	226	195·7	113·0	286	247·7	143·0
47	40·7	23·5	107	92·7	53·5	167	144·6	83·5	227	196·6	113·5	287	248·5	143·5
48	41·6	24·0	108	93·5	54·0	168	145·5	84·0	228	197·5	114·0	288	249·4	144·0
49	42·4	24·5	109	94·4	54·5	169	146·4	84·5	229	198·3	114·5	289	250·3	144·5
50	43·3	25·0	110	95·3	55·0	170	147·2	85·0	230	199·2	115·0	290	251·1	145·0
51	44·2	25·5	111	96·1	55·5	171	148·1	85·5	231	200·1	115·5	291	252·0	145·5
52	45·0	26·0	112	97·0	56·0	172	149·0	86·0	232	200·9	116·0	292	252·9	146·0
53	45·9	26·5	113	97·9	56·5	173	149·8	86·5	233	201·8	116·5	293	253·7	146·5
54	46·8	27·0	114	98·7	57·0	174	150·7	87·0	234	202·6	117·0	294	254·6	147·0
55	47·6	27·5	115	99·6	57·5	175	151·6	87·5	235	203·5	117·5	295	255·5	147·5
56	48·5	28·0	116	100·5	58·0	176	152·4	88·0	236	204·4	118·0	296	256·3	148·0
57	49·4	28·5	117	101·3	58·5	177	153·3	88·5	237	205·2	118·5	297	257·2	148·5
58	50·2	29·0	118	102·2	59·0	178	154·2	89·0	238	206·1	119·0	298	258·1	149·0
59	51·1	29·5	119	103·1	59·5	179	155·0	89·5	239	207·0	119·5	299	258·9	149·5
60	52·0	30·0	120	103·9	60·0	180	155·9	90·0	240	207·8	120·0	300	259·8	150·0
Dist.	Dep.	D.Lat.	Dist.	Dep.	D.Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

60° — $4^h\ 0^m$

TRAVERSE TABLE TO DEGREES

30°														2h 0m
Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	260·7	150·5	361	312·6	180·5	421	364·6	210·5	481	416·6	240·5	541	468·5	270·5
302	261·5	151·0	362	313·5	181·0	422	365·5	211·0	482	417·4	241·0	542	469·4	271·0
303	262·4	151·5	363	314·4	181·5	423	366·3	211·5	483	418·3	241·5	543	470·3	271·5
304	263·3	152·0	364	315·2	182·0	424	367·2	212·0	484	419·2	242·0	544	471·1	272·0
305	264·1	152·5	365	316·1	182·5	425	368·1	212·5	485	420·0	242·5	545	472·0	272·5
306	265·0	153·0	366	317·0	183·0	426	368·9	213·0	486	420·9	243·0	546	472·9	273·0
307	265·9	153·5	367	317·8	183·5	427	369·8	213·5	487	421·8	243·5	547	473·7	273·5
308	266·7	154·0	368	318·7	184·0	428	370·7	214·0	488	422·6	244·0	548	474·6	274·0
309	267·6	154·5	369	319·6	184·5	429	371·5	214·5	489	423·5	244·5	549	475·5	274·5
310	268·5	155·0	370	320·4	185·0	430	372·4	215·0	490	424·4	245·0	550	476·3	275·0
311	269·3	155·5	371	321·3	185·5	431	373·3	215·5	491	425·2	245·5	551	477·2	275·5
312	270·2	156·0	372	322·2	186·0	432	374·1	216·0	492	426·1	246·0	552	478·1	276·0
313	271·1	156·5	373	323·0	186·5	433	375·0	216·5	493	426·9	246·5	553	478·9	276·5
314	271·9	157·0	374	323·9	187·0	434	375·9	217·0	494	427·8	247·0	554	479·8	277·0
315	272·8	157·5	375	324·8	187·5	435	376·7	217·5	495	428·7	247·5	555	480·7	277·5
316	273·7	158·0	376	325·6	188·0	436	377·6	218·0	496	429·6	248·0	556	481·5	278·0
317	274·5	158·5	377	326·5	188·5	437	378·5	218·5	497	430·4	248·5	557	482·4	278·5
318	275·4	159·0	378	327·4	189·0	438	579·3	219·0	498	431·3	249·0	558	483·3	279·0
319	276·3	159·5	379	328·2	189·5	439	380·2	219·5	499	432·2	249·5	559	484·1	279·5
320	277·1	160·0	380	329·1	190·0	440	381·1	220·0	500	433·0	250·0	560	485·0	280·0
321	278·0	160·5	381	330·0	190·5	441	381·9	220·5	501	433·9	250·5	561	485·9	280·5
322	278·9	161·0	382	330·8	191·0	442	382·8	221·0	502	434·8	251·0	562	486·7	281·0
323	279·7	161·5	383	331·7	191·5	443	383·7	221·5	503	435·6	251·5	563	487·6	281·5
324	280·6	162·0	384	332·6	192·0	444	384·5	222·0	504	436·5	252·0	564	488·5	282·0
325	281·5	162·5	385	333·4	192·5	445	385·4	222·5	505	437·4	252·5	565	489·3	282·5
326	282·3	163·0	386	334·3	193·0	446	386·3	223·0	506	438·2	253·0	566	490·2	283·0
327	283·2	163·5	387	335·2	193·5	447	387·1	223·5	507	439·1	253·5	567	491·1	283·5
328	284·1	164·0	388	336·0	194·0	448	388·0	224·0	508	440·0	254·0	568	491·9	284·0
329	284·9	164·5	389	336·9	194·5	449	388·9	224·5	509	440·8	254·5	569	492·8	284·5
330	285·8	165·0	390	337·8	195·0	450	389·7	225·0	510	441·7	255·0	570	493·6	285·0
331	286·7	165·5	391	338·6	195·5	451	390·6	225·5	511	442·6	255·5	571	494·5	285·5
332	287·5	166·0	392	339·5	196·0	452	391·5	226·0	512	443·4	256·0	572	495·4	286·0
333	288·4	166·5	393	340·4	196·5	453	392·3	226·5	513	444·3	256·5	573	496·3	286·5
334	289·3	167·0	394	341·2	197·0	454	393·2	227·0	514	445·2	257·0	574	497·1	287·0
335	290·1	167·5	395	342·1	197·5	455	394·0	227·5	515	446·0	257·5	575	497·9	287·5
336	291·0	168·0	396	343·0	198·0	456	394·9	228·0	516	446·9	258·0	576	498·8	288·0
337	291·9	168·5	397	343·8	198·5	457	395·8	228·5	517	447·8	258·5	577	499·7	288·5
338	292·7	169·0	398	344·7	199·0	458	396·6	229·0	518	448·6	259·0	578	500·5	289·0
339	293·6	169·5	399	345·6	199·5	459	397·5	229·5	519	449·4	259·5	579	501·3	289·5
340	294·5	170·0	400	346·4	200·0	460	398·4	230·0	520	450·3	260·0	580	502·2	290·0
341	295·3	170·5	401	347·3	200·5	461	399·2	230·5	521	451·2	260·5	581	503·1	290·5
342	296·2	171·0	402	348·1	201·0	462	400·1	231·0	522	452·1	261·0	582	504·0	291·0
343	297·1	171·5	403	349·0	201·5	463	401·0	231·5	523	452·9	261·5	583	504·9	291·5
344	297·9	172·0	404	349·9	202·0	464	401·8	232·0	524	453·8	262·0	584	505·8	292·0
345	298·8	172·5	405	350·7	202·5	465	402·7	232·5	525	454·7	262·5	585	506·6	292·5
346	299·7	173·0	406	351·6	203·0	466	403·6	233·0	526	455·5	263·0	586	507·5	293·0
347	300·5	173·5	407	352·5	203·5	467	404·4	233·5	527	456·4	263·5	587	508·4	293·5
348	301·4	174·0	408	353·3	204·0	468	405·3	234·0	528	457·3	264·0	588	509·2	294·0
349	302·3	174·5	409	354·2	204·5	469	406·2	234·5	529	458·1	264·5	589	510·1	294·5
350	303·1	175·0	410	355·1	205·0	470	407·0	235·0	530	459·0	265·0	590	511·0	295·0
351	304·0	175·5	411	355·9	205·5	471	407·9	235·5	531	459·9	265·5	591	511·8	295·5
352	304·8	176·0	412	356·8	206·0	472	408·8	236·0	532	460·7	266·0	592	512·7	296·0
353	305·7	176·5	413	357·7	206·5	473	409·6	236·5	533	461·6	266·5	593	513·6	296·5
354	306·6	177·0	414	358·5	207·0	474	410·5	237·0	534	462·5	267·0	594	514·4	297·0
355	307·4	177·5	415	359·4	207·5	475	411·4	237·5	535	463·3	267·5	595	515·3	297·5
356	308·3	178·0	416	360·3	208·0	476	412·2	238·0	536	464·2	268·0	596	516·2	298·0
357	309·2	178·5	417	361·1	208·5	477	413·1	238·5	537	465·1	268·5	597	517·0	298·5
358	310·0	179·0	418	362·0	209·0	478	414·0	239·0	538	465·9	269·0	598	517·9	299·0
359	310·9	179·5	419	362·9	209·5	479	414·8	239·5	539	466·8	269·5	599	518·8	299·5
360	311·8	180·0	420	363·7	210·0	480	415·7	240·0	540	467·7	270·0	600	519·6	300·0
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.
60°														4h 0m

TRAVERSE TABLE TO DEGREES

31° 2ʰ 4ᵐ

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·9	0·5	61	52·3	31·4	121	103·7	62·3	181	155·1	93·2	241	206·6	124·1
2	1·7	1·0	62	53·1	31·9	122	104·6	62·8	182	156·0	93·7	242	207·4	124·6
3	2·6	1·5	63	54·0	32·4	123	105·4	63·3	183	156·9	94·3	243	208·3	125·2
4	3·4	2·1	64	54·9	33·0	124	106·3	63·9	184	157·7	94·8	244	209·1	125·7
5	4·3	2·6	65	55·7	33·5	125	107·1	64·4	185	158·6	95·3	245	210·0	126·2
6	5·1	3·1	66	56·6	34·0	126	108·0	64·9	186	159·4	95·8	246	210·9	126·7
7	6·0	3·6	67	57·4	34·5	127	108·9	65·4	187	160·3	96·3	247	211·7	127·2
8	6·9	4·1	68	58·3	35·0	128	109·7	65·9	188	161·1	96·8	248	212·6	127·7
9	7·7	4·6	69	59·1	35·5	129	110·6	66·4	189	162·0	97·3	249	213·4	128·2
10	8·6	5·2	70	60·0	36·1	130	111·4	67·0	190	162·9	97·9	250	214·3	128·8
11	9·4	5·7	71	60·9	36·6	131	112·3	67·5	191	163·7	98·4	251	215·1	129·3
12	10·3	6·2	72	61·7	37·1	132	113·1	68·0	192	164·6	98·9	252	216·0	129·8
13	11·1	6·7	73	62·6	37·6	133	114·0	68·5	193	165·4	99·4	253	216·9	130·3
14	12·0	7·2	74	63·4	38·1	134	114·9	69·0	194	166·3	99·9	254	217·7	130·8
15	12·9	7·7	75	64·3	38·6	135	115·7	69·5	195	167·1	100·4	255	218·6	131·3
16	13·7	8·2	76	65·1	39·1	136	116·6	70·0	196	168·0	100·9	256	219·4	131·8
17	14·6	8·8	77	66·0	39·7	137	117·4	70·6	197	168·9	101·5	257	220·3	132·4
18	15·4	9·3	78	66·9	40·2	138	118·3	71·1	198	169·7	102·0	258	221·1	132·9
19	16·3	9·8	79	67·7	40·7	139	119·1	71·6	199	170·6	102·5	259	222·0	133·4
20	17·1	10·3	80	68·6	41·2	140	120·0	72·1	200	171·4	103·0	260	222·9	133·9
21	18·0	10·8	81	69·4	41·7	141	120·9	72·6	201	172·3	103·5	261	223·7	134·4
22	18·9	11·3	82	70·3	42·2	142	121·7	73·1	202	173·1	104·0	262	224·6	134·9
23	19·7	11·8	83	71·1	42·7	143	122·6	73·7	203	174·0	104·6	263	225·4	135·5
24	20·6	12·4	84	72·0	43·3	144	123·4	74·2	204	174·9	105·1	264	226·3	136·0
25	21·4	12·9	85	72·9	43·8	145	124·3	74·7	205	175·7	105·6	265	227·1	136·5
26	22·3	13·4	86	73·7	44·3	146	125·1	75·2	206	176·6	106·1	266	228·0	137·0
27	23·1	13·9	87	74·6	44·8	147	126·0	75·7	207	177·4	106·6	267	228·9	137·5
28	24·0	14·4	88	75·4	45·3	148	126·9	76·2	208	178·3	107·1	268	229·7	138·0
29	24·9	14·9	89	76·3	45·8	149	127·7	76·7	209	179·1	107·6	269	230·6	138·5
30	25·7	15·5	90	77·1	46·4	150	128·6	77·3	210	180·0	108·2	270	231·4	139·1
31	26·6	16·0	91	78·0	46·9	151	129·4	77·8	211	180·9	108·7	271	232·3	139·6
32	27·4	16·5	92	78·9	47·4	152	130·3	78·3	212	181·7	109·2	272	233·1	140·1
33	28·3	17·0	93	79·7	47·9	153	131·1	78·8	213	182·6	109·7	273	234·0	140·6
34	29·1	17·5	94	80·6	48·4	154	132·0	79·3	214	183·4	110·2	274	234·9	141·1
35	30·0	18·0	95	81·4	48·9	155	132·9	79·8	215	184·3	110·7	275	235·7	141·6
36	30·9	18·5	96	82·3	49·4	156	133·7	80·3	216	185·1	111·2	276	236·6	142·2
37	31·7	19·1	97	83·1	50·0	157	134·6	80·9	217	186·0	111·8	277	237·4	142·7
38	32·6	19·6	98	84·0	50·5	158	135·4	81·4	218	186·9	112·3	278	238·3	143·2
39	33·4	20·1	99	84·9	51·0	159	136·3	81·9	219	187·7	112·8	279	239·1	143·7
40	34·3	20·6	100	85·7	51·5	160	137·1	82·4	220	188·6	113·3	280	240·0	144·2
41	35·1	21·1	101	86·6	52·0	161	138·0	82·9	221	189·4	113·8	281	240·9	144·7
42	36·0	21·6	102	87·4	52·5	162	138·9	83·4	222	190·3	114·3	282	241·7	145·2
43	36·9	22·1	103	88·3	53·0	163	139·7	84·0	223	191·1	114·9	283	242·6	145·8
44	37·7	22·7	104	89·1	53·6	164	140·6	84·5	224	192·0	115·4	284	243·4	146·3
45	38·6	23·2	105	90·0	54·1	165	141·4	85·0	225	192·9	115·9	285	244·3	146·8
46	39·4	23·7	106	90·9	54·6	166	142·3	85·5	226	193·7	116·4	286	245·1	147·3
47	40·3	24·2	107	91·7	55·1	167	143·1	86·0	227	194·6	116·9	287	246·0	147·8
48	41·1	24·7	108	92·6	55·6	168	144·0	86·5	228	195·4	117·4	288	246·9	148·3
49	42·0	25·2	109	93·4	56·1	169	144·9	87·0	229	196·3	117·9	289	247·7	148·8
50	42·9	25·8	110	94·3	56·7	170	145·7	87·6	230	197·1	118·5	290	248·6	149·4
51	43·7	26·3	111	95·1	57·2	171	146·6	88·1	231	198·0	119·0	291	249·4	149·9
52	44·6	26·8	112	96·0	57·7	172	147·4	88·6	232	198·9	119·5	292	250·3	150·4
53	45·4	27·3	113	96·9	58·2	173	148·3	89·1	233	199·7	120·0	293	251·2	150·9
54	46·3	27·8	114	97·7	58·7	174	149·1	89·6	234	200·6	120·5	294	252·0	151·4
55	47·1	28·3	115	98·6	59·2	175	150·0	90·1	235	201·4	121·0	295	252·9	151·9
56	48·0	28·8	116	99·4	59·7	176	150·9	90·6	236	202·3	121·5	296	253·7	152·5
57	48·9	29·4	117	100·3	60·3	177	151·7	91·2	237	203·1	122·1	297	254·6	153·0
58	49·7	29·9	118	101·1	60·8	178	152·6	91·7	238	204·0	122·6	298	255·4	153·5
59	50·6	30·4	119	102·0	61·3	179	153·4	92·2	239	204·9	123·1	299	256·3	154·0
60	51·4	30·9	120	102·9	61·8	180	154·3	92·7	240	205·7	123·6	300	257·1	154·5
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

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TRAVERSE TABLE TO DEGREES

31° 2h 4m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	258.0	155.0	361	309.4	185.9	421	360.9	216.8	481	412.3	247.7	541	463.7	278.6
302	258.9	155.5	362	310.3	186.4	422	361.7	217.3	482	413.2	248.2	542	464.6	279.1
303	259.7	156.1	363	311.2	187.0	423	362.6	217.9	483	414.0	248.8	543	465.4	279.7
304	260.6	156.6	364	312.0	187.5	424	363.4	218.4	484	414.9	249.3	544	466.3	280.2
305	261.4	157.1	365	312.9	188.0	425	364.3	218.9	485	415.7	249.8	545	467.2	280.7
306	262.3	157.6	366	313.7	188.5	426	365.2	219.4	486	416.6	250.3	546	468.0	281.2
307	263.2	158.1	367	314.6	189.0	427	366.0	219.9	487	417.4	250.8	547	468.9	281.7
308	264.0	158.6	368	315.4	189.5	428	366.9	220.4	488	418.3	251.3	548	469.7	282.3
309	264.9	159.2	369	316.3	190.1	429	367.7	221.0	489	419.2	251.9	549	470.6	282.8
310	265.7	159.7	370	317.2	190.6	430	368.6	221.5	490	420.0	252.4	550	471.4	283.3
311	266.6	160.2	371	318.0	191.1	431	369.4	222.0	491	420.9	252.9	551	472.3	283.8
312	267.4	160.7	372	318.9	191.6	432	370.3	222.5	492	421.7	253.4	552	473.2	284.3
313	268.3	161.2	373	319.7	192.1	433	371.2	223.0	493	422.6	253.9	553	474.0	284.8
314	269.2	161.7	374	320.6	192.6	434	372.0	223.5	494	423.4	254.4	554	474.9	285.3
315	270.0	162.2	375	321.4	193.1	435	372.9	224.0	495	424.3	254.9	555	475.7	285.8
316	270.9	162.8	376	322.3	193.7	436	373.7	224.6	496	425.2	255.5	556	476.6	286.4
317	271.7	163.3	377	323.2	194.2	437	374.6	225.1	497	426.0	256.0	557	477.4	286.9
318	272.6	163.8	378	324.0	194.7	438	375.4	225.6	498	426.9	256.5	558	478.3	287.4
319	273.4	164.3	379	324.9	195.2	439	376.3	226.1	499	427.7	257.0	559	479.2	287.9
320	274.3	164.8	380	325.7	195.7	440	377.2	226.6	500	428.6	257.5	560	480.0	288.4
321	275.2	165.3	381	326.6	196.2	441	378.0	227.1	501	429.4	258.0	561	480.9	288.9
322	276.0	165.8	382	327.4	196.7	442	378.9	227.7	502	430.3	258.6	562	481.7	289.5
323	276.9	166.4	383	328.3	197.3	443	379.7	228.2	503	431.2	259.1	563	482.6	290.0
324	277.7	166.9	384	329.2	197.8	444	380.6	228.7	504	432.0	259.6	564	483.4	290.5
325	278.6	167.4	385	330.0	198.3	445	381.4	229.2	505	432.9	260.1	565	484.3	291.0
326	279.4	167.9	386	330.9	198.8	446	382.3	229.7	506	433.7	260.6	566	485.2	291.5
327	280.3	168.4	387	331.7	199.3	447	383.2	230.2	507	434.6	261.1	567	486.0	292.0
328	281.2	168.9	388	332.6	199.8	448	384.0	230.7	508	435.4	261.6	568	486.9	292.5
329	282.0	169.5	389	333.4	200.4	449	384.9	231.3	509	436.3	262.2	569	487.7	293.1
330	282.9	170.0	390	334.3	200.9	450	385.7	231.8	510	437.2	262.7	570	488.6	293.6
331	283.7	170.5	391	335.2	201.4	451	386.6	232.3	511	438.0	263.2	571	489.4	294.1
332	284.6	171.0	392	336.0	201.9	452	387.4	232.8	512	438.9	263.7	572	490.3	294.6
333	285.4	171.5	393	336.9	202.4	453	388.3	233.3	513	439.7	264.2	573	491.2	295.1
334	286.3	172.0	394	337.7	202.9	454	389.2	233.8	514	440.6	264.7	574	492.0	295.6
335	287.2	172.5	395	338.6	203.4	455	390.0	234.3	515	441.4	265.2	575	492.9	296.1
336	288.0	173.1	396	339.4	204.0	456	390.9	234.9	516	442.3	265.8	576	493.7	296.7
337	288.9	173.6	397	340.3	204.5	457	391.7	235.4	517	443.2	266.3	577	494.6	297.2
338	289.7	174.1	398	341.2	205.0	458	392.6	235.9	518	444.0	266.8	578	495.4	297.7
339	290.6	174.6	399	342.0	205.5	459	393.4	236.4	519	444.9	267.3	579	496.3	298.2
340	291.4	175.1	400	342.9	206.0	460	394.3	236.9	520	445.7	267.8	580	497.2	298.7
341	292.3	175.6	401	343.7	206.5	461	395.2	237.4	521	446.6	268.3	581	498.0	299.2
342	293.2	176.1	402	344.6	207.0	462	396.0	238.0	522	447.4	268.9	582	498.9	299.8
343	294.0	176.7	403	345.4	207.6	463	396.9	238.5	523	448.3	269.4	583	499.7	300.3
344	294.9	177.2	404	346.3	208.1	464	397.7	239.0	524	449.2	269.9	584	500.6	300.8
345	295.7	177.7	405	347.2	208.6	465	398.6	239.5	525	450.0	270.4	585	501.4	301.3
346	296.6	178.2	406	348.0	209.1	466	399.4	240.0	526	450.9	270.9	586	502.3	301.8
347	297.4	178.7	407	348.9	209.6	467	400.3	240.5	527	451.7	271.4	587	503.2	302.3
348	298.3	179.2	408	349.7	210.1	468	401.2	241.0	528	452.6	271.9	588	504.0	302.8
349	299.2	179.8	409	350.6	210.7	469	402.0	241.5	529	453.4	272.4	589	504.9	303.3
350	300.0	180.3	410	351.4	211.2	470	402.9	242.1	530	454.3	273.0	590	505.7	303.9
351	300.9	180.8	411	352.3	211.7	471	403.7	242.6	531	455.2	273.5	591	506.6	304.4
352	301.7	181.3	412	353.2	212.2	472	404.6	243.1	532	456.0	274.0	592	507.4	304.9
353	302.6	181.8	413	354.0	212.7	473	405.4	243.6	533	456.9	274.5	593	508.3	305.4
354	303.4	182.3	414	354.9	213.2	474	406.3	244.1	534	457.7	275.0	594	509.2	305.9
355	304.3	182.8	415	355.7	213.7	475	407.2	244.6	535	458.6	275.5	595	510.0	306.4
356	305.2	183.4	416	356.6	214.3	476	408.0	245.2	536	459.4	276.1	596	510.9	307.0
357	306.0	183.9	417	357.4	214.8	477	408.9	245.7	537	460.3	276.6	597	511.7	307.5
358	306.9	184.4	418	358.3	215.3	478	409.7	246.2	538	461.2	277.1	598	512.6	308.0
359	307.7	184.9	419	359.2	215.8	479	410.6	246.7	539	462.0	277.6	599	513.4	308.5
360	308.6	185.4	420	360.0	216.3	480	411.4	247.2	540	462.9	278.1	600	514.3	309.0
Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat.

59° 3h 56m

TRAVERSE TABLE TO DEGREES

32° — 2h 8m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·8	0·5	61	51·7	32·3	121	102·6	64·1	181	153·5	95·9	241	204·4	127·7
2	1·7	1·1	62	52·6	32·9	122	103·5	64·7	182	154·3	96·4	242	205·2	128·2
3	2·5	1·6	63	53·4	33·4	123	104·3	65·2	183	155·2	97·0	243	206·1	128·8
4	3·4	2·1	64	54·3	33·9	124	105·2	65·7	184	156·0	97·5	244	206·9	129·3
5	4·2	2·6	65	55·1	34·4	125	106·0	66·2	185	156·9	98·0	245	207·8	129·8
6	5·1	3·2	66	56·0	35·0	126	106·9	66·8	186	157·7	98·6	246	208·6	130·4
7	5·9	3·7	67	56·8	35·5	127	107·7	67·3	187	158·6	99·1	247	209·5	130·9
8	6·8	4·2	68	57·7	36·0	128	108·6	67·8	188	159·4	99·6	248	210·3	131·4
9	7·6	4·8	69	58·5	36·6	129	109·4	68·4	189	160·3	100·2	249	211·2	131·9
10	8·5	5·3	70	59·4	37·1	130	110·2	68·9	190	161·1	100·7	250	212·0	132·5
11	9·3	5·8	71	60·2	37·6	131	111·1	69·4	191	162·0	101·2	251	212·9	133·0
12	10·2	6·4	72	61·1	38·2	132	111·9	69·9	192	162·8	101·7	252	213·7	133·5
13	11·0	6·9	73	61·9	38·7	133	112·8	70·5	193	163·7	102·3	253	214·6	134·1
14	11·9	7·4	74	62·8	39·2	134	113·6	71·0	194	164·5	102·8	254	215·4	134·6
15	12·7	7·9	75	63·6	39·7	135	114·5	71·5	195	165·4	103·3	255	216·3	135·1
16	13·6	8·5	76	64·5	40·3	136	115·3	72·1	196	166·2	103·9	256	217·1	135·7
17	14·4	9·0	77	65·3	40·8	137	116·2	72·6	197	167·1	104·4	257	217·9	136·2
18	15·3	9·5	78	66·1	41·3	138	117·0	73·1	198	167·9	104·9	258	218·8	136·7
19	16·1	10·1	79	67·0	41·9	139	117·9	73·7	199	168·8	105·5	259	219·6	137·2
20	17·0	10·6	80	67·8	42·4	140	118·7	74·2	200	169·6	106·0	260	220·5	137·8
21	17·8	11·1	81	68·7	42·9	141	119·6	74·7	201	170·5	106·5	261	221·3	138·3
22	18·7	11·7	82	69·5	43·5	142	120·4	75·2	202	171·3	107·0	262	222·2	138·8
23	19·5	12·2	83	70·4	44·0	143	121·3	75·8	203	172·2	107·6	263	223·0	139·4
24	20·4	12·7	84	71·2	44·5	144	122·1	76·3	204	173·0	108·1	264	223·9	139·9
25	21·2	13·2	85	72·1	45·0	145	123·0	76·8	205	173·8	108·6	265	224·7	140·4
26	22·0	13·8	86	72·9	45·6	146	123·8	77·4	206	174·7	109·2	266	225·6	141·0
27	22·9	14·3	87	73·8	46·1	147	124·7	77·9	207	175·5	109·7	267	226·4	141·5
28	23·7	14·8	88	74·6	46·6	148	125·5	78·4	208	176·4	110·2	268	227·3	142·0
29	24·6	15·4	89	75·5	47·2	149	126·4	79·0	209	177·2	110·8	269	228·1	142·5
30	25·4	15·9	90	76·3	47·7	150	127·2	79·5	210	178·1	111·3	270	229·0	143·1
31	26·3	16·4	91	77·2	48·2	151	128·1	80·0	211	178·9	111·8	271	229·8	143·6
32	27·1	17·0	92	78·0	48·8	152	128·9	80·5	212	179·8	112·3	272	230·7	144·1
33	28·0	17·5	93	78·9	49·3	153	129·8	81·1	213	180·6	112·9	273	231·5	144·7
34	28·8	18·0	94	79·7	49·8	154	130·6	81·6	214	181·5	113·4	274	232·4	145·2
35	29·7	18·5	95	80·6	50·3	155	131·4	82·1	215	182·3	113·9	275	233·2	145·7
36	30·5	19·1	96	81·4	50·9	156	132·3	82·7	216	183·2	114·5	276	234·1	146·3
37	31·4	19·6	97	82·3	51·4	157	133·1	83·2	217	184·0	115·0	277	234·9	146·8
38	32·2	20·1	98	83·1	51·9	158	134·0	83·7	218	184·9	115·5	278	235·8	147·3
39	33·1	20·7	99	84·0	52·5	159	134·8	84·3	219	185·7	116·1	279	236·6	147·8
40	33·9	21·2	100	84·8	53·0	160	135·7	84·8	220	186·6	116·6	280	237·5	148·4
41	34·8	21·7	101	85·7	53·5	161	136·5	85·3	221	187·4	117·1	281	238·3	148·9
42	35·6	22·3	102	86·5	54·1	162	137·4	85·8	222	188·3	117·6	282	239·1	149·4
43	36·5	22·8	103	87·3	54·6	163	138·2	86·4	223	189·1	118·2	283	240·0	150·0
44	37·3	23·3	104	88·2	55·1	164	139·1	86·9	224	190·0	118·7	284	240·8	150·5
45	38·2	23·8	105	89·0	55·6	165	139·9	87·4	225	190·8	119·2	285	241·7	151·0
46	39·0	24·4	106	89·9	56·2	166	140·8	88·0	226	191·7	119·8	286	242·5	151·6
47	39·9	24·9	107	90·7	56·7	167	141·6	88·5	227	192·5	120·3	287	243·4	152·1
48	40·7	25·4	108	91·6	57·2	168	142·5	89·0	228	193·4	120·8	288	244·2	152·6
49	41·6	26·0	109	92·4	57·8	169	143·3	89·6	229	194·2	121·4	289	245·1	153·1
50	42·4	26·5	110	93·3	58·3	170	144·2	90·1	230	195·1	121·9	290	245·9	153·7
51	43·3	27·0	111	94·1	58·8	171	145·0	90·6	231	195·9	122·4	291	246·8	154·2
52	44·1	27·6	112	95·0	59·4	172	145·9	91·1	232	196·7	122·9	292	247·6	154·7
53	44·9	28·1	113	95·8	59·9	173	146·7	91·7	233	197·6	123·5	293	248·5	155·3
54	45·8	28·6	114	96·7	60·4	174	147·6	92·2	234	198·4	124·0	294	249·3	155·8
55	46·6	29·1	115	97·5	60·9	175	148·4	92·7	235	199·3	124·5	295	250·2	156·3
56	47·5	29·7	116	98·4	61·5	176	149·3	93·3	236	200·1	125·1	296	251·0	156·9
57	48·3	30·2	117	99·2	62·0	177	150·1	93·8	237	201·0	125·6	297	251·9	157·4
58	49·2	30·7	118	100·1	62·5	178	151·0	94·3	238	201·8	126·1	298	252·7	157·9
59	50·0	31·3	119	100·9	63·1	179	151·8	94·9	239	202·7	126·7	299	253·6	158·4
60	50·9	31·8	120	101·8	63·6	180	152·6	95·4	240	203·5	127·2	300	254·4	159·0
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

58° — 3h 52m

TRAVERSE TABLE TO DEGREES

32° — $2^h\ 8^m$

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	255·3	159·5	361	306·2	191·3	421	357·0	223·1	481	407·9	254·9	541	458·8	286·7
302	256·1	160·0	362	307·0	191·8	422	357·9	223·6	482	408·8	255·4	542	459·6	287·2
303	257·0	160·5	363	307·9	192·3	423	358·7	224·1	483	409·6	255·9	543	460·5	287·7
304	257·8	161·1	364	308·7	192·9	424	359·6	224·7	484	410·5	256·5	544	461·3	288·3
305	258·7	161·6	365	309·5	193·4	425	360·4	225·2	485	411·3	257·0	545	462·2	288·8
306	259·5	162·1	366	310·4	193·9	426	361·3	225·7	486	412·2	257·5	546	463·0	289·3
307	260·4	162·7	367	311·2	194·5	427	362·1	226·3	487	413·0	258·1	547	463·9	289·9
308	261·2	163·2	368	312·1	195·0	428	363·0	226·8	488	413·9	258·6	548	464·7	290·4
309	262·1	163·7	369	312·9	195·5	429	363·8	227·3	489	414·7	259·1	549	465·6	290·9
310	262·9	164·3	370	313·8	196·0	430	364·7	227·8	490	415·6	259·6	550	466·4	291·5
311	263·8	164·8	371	314·6	196·6	431	365·5	228·4	491	416·4	260·2	551	467·3	292·0
312	264·6	165·3	372	315·5	197·1	432	366·4	228·9	492	417·3	260·7	552	468·1	292·5
313	265·4	165·8	373	316·3	197·6	433	367·2	229·4	493	418·1	261·2	553	469·0	293·0
314	266·3	166·4	374	317·2	198·2	434	368·1	230·0	494	419·0	261·8	554	469·8	293·6
315	267·1	166·9	375	318·0	198·7	435	368·9	230·5	495	419·8	262·3	555	470·7	294·1
316	268·0	167·4	376	318·9	199·2	436	369·8	231·0	496	420·6	262·8	556	471·5	294·6
317	268·8	168·0	377	319·7	199·8	437	370·6	231·6	497	421·5	263·4	557	472·4	295·2
318	269·7	168·5	378	320·6	200·3	438	371·5	232·1	498	422·3	263·9	558	473·2	295·7
319	270·5	169·0	379	321·4	200·8	439	372·3	232·6	499	423·2	264·4	559	474·1	296·2
320	271·4	169·6	380	322·3	201·3	440	373·2	233·1	500	424·0	265·0	560	474·9	296·7
321	272·2	170·1	381	323·1	201·9	441	374·0	233·7	501	424·9	265·5	561	475·8	297·3
322	273·1	170·6	382	324·0	202·4	442	374·8	234·2	502	425·7	266·0	562	476·6	297·8
323	273·9	171·1	383	324·8	202·9	443	375·7	234·7	503	426·6	266·5	563	477·5	298·3
324	274·8	171·7	384	325·7	203·5	444	376·5	235·3	504	427·4	267·1	564	478·3	298·9
325	275·6	172·2	385	326·5	204·0	445	377·4	235·8	505	428·3	267·6	565	479·2	299·4
326	276·5	172·7	386	327·4	204·5	446	378·2	236·3	506	429·1	268·1	566	480·0	299·9
327	277·3	173·3	387	328·2	205·1	447	379·1	236·9	507	430·0	268·7	567	480·9	300·5
328	278·2	173·8	388	329·1	205·6	448	379·9	237·4	508	430·8	269·2	568	481·7	301·0
329	279·0	174·3	389	329·9	206·1	449	380·8	237·9	509	431·7	269·7	569	482·6	301·5
330	279·9	174·9	390	330·8	206·6	450	381·6	238·4	510	432·5	270·3	570	483·4	302·1
331	280·7	175·4	391	331·6	207·2	451	382·5	239·0	511	433·4	270·8	571	484·3	302·6
332	281·6	175·9	392	332·5	207·7	452	383·3	239·5	512	434·2	271·4	572	485·1	303·2
333	282·4	176·4	393	333·3	208·2	453	384·2	240·0	513	435·1	271·9	573	486·0	303·7
334	283·3	177·0	394	334·2	208·8	454	385·0	240·6	514	435·9	272·4	574	486·8	304·2
335	284·1	177·5	395	335·0	209·3	455	385·9	241·1	515	436·8	272·9	575	487·7	304·7
336	285·0	178·0	396	335·8	209·8	456	386·7	241·6	516	437·6	273·5	576	488·5	305·3
337	285·8	178·6	397	336·7	210·4	457	387·6	242·2	517	438·5	274·0	577	489·4	305·8
338	286·7	179·1	398	337·5	210·9	458	388·4	242·7	518	439·3	274·5	578	490·2	306·3
339	287·5	179·6	399	338·4	211·4	459	389·3	243·2	519	440·2	275·0	579	491·1	306·8
340	288·3	180·2	400	339·2	211·9	460	390·1	243·8	520	441·0	275·6	580	491·9	307·4
341	289·2	180·7	401	340·1	212·5	461	391·0	244·3	521	441·9	276·1	581	492·8	307·9
342	290·0	181·2	402	340·9	213·0	462	391·8	244·8	522	442·7	276·6	582	493·6	308·4
343	290·9	181·7	403	341·8	213·5	463	392·7	245·4	523	443·6	277·2	583	494·5	309·0
344	291·7	182·3	404	342·6	214·1	464	393·5	245·9	524	444·4	277·7	584	495·3	309·5
345	292·6	182·8	405	343·5	214·6	465	394·4	246·4	525	445·3	278·2	585	496·2	310·0
346	293·4	183·3	406	344·3	215·1	466	395·2	246·9	526	446·1	278·7	586	497·0	310·5
347	294·3	183·9	407	345·2	215·7	467	396·0	247·5	527	446·9	279·3	587	497·8	311·1
348	295·1	184·4	408	346·0	216·2	468	396·9	248·0	528	447·8	279·8	588	498·7	311·6
349	296·0	184·9	409	346·9	216·7	469	397·7	248·5	529	448·6	280·3	589	499·5	312·1
350	296·8	185·4	410	347·7	217·2	470	398·6	249·0	530	449·5	280·9	590	500·3	312·6
351	297·7	186·0	411	348·6	217·8	471	399·4	249·6	531	450·3	281·4	591	501·2	313·2
352	298·5	186·5	412	349·4	218·3	472	400·3	250·1	532	451·1	281·9	592	502·0	313·7
353	299·4	187·0	413	350·3	218·8	473	401·1	250·6	533	452·0	282·4	593	502·9	314·2
354	300·2	187·6	414	351·1	219·4	474	402·0	251·2	534	452·8	283·0	594	503·7	314·8
355	301·1	188·1	415	352·0	219·9	475	402·8	251·7	535	453·7	283·5	595	504·6	315·3
356	301·9	188·6	416	352·8	220·4	476	403·7	252·2	536	454·5	284·0	596	505·4	315·8
357	302·8	189·2	417	353·6	221·0	477	404·5	252·8	537	455·4	284·6	597	506·2	316·4
358	303·6	189·7	418	354·5	221·5	478	405·4	253·3	538	456·2	285·1	598	507·1	316·9
359	304·5	190·2	419	355·3	222·0	479	406·2	253·8	539	457·1	285·6	599	508·0	317·4
360	305·3	190·8	420	356·2	222·5	480	407·1	254·3	540	457·9	286·2	600	508·8	318·0
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

58° — $3^h\ 52^m$

TRAVERSE TABLE TO DEGREES

34° — $2^h\ 16^m$

Dist.	D.Lat	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·8	0·6	61	50·6	34·1	121	100·3	67·7	181	150·1	101·2	241	199·8	134·8
2	1·7	1·1	62	51·4	34·7	122	101·1	68·2	182	150·9	101·8	242	200·6	135·3
3	2·5	1·7	63	52·2	35·2	123	102·0	68·8	183	151·7	102·3	243	201 5	135·9
4	3·3	2·2	64	53·1	35·8	124	102·8	69·3	184	152·5	102·9	244	202·3	136·4
5	4·1	2·8	65	53·9	36·3	125	103·6	69·9	185	153·4	103·5	245	203·1	137·0
6	5·0	3·4	66	54·7	36·9	126	104·5	70·5	186	154·2	104·0	246	203·9	137·6
7	5·8	3·9	67	55·5	37·5	127	105·3	71·0	187	155·0	104·6	247	204·8	138·1
8	6·6	4·5	68	56·4	38·0	128	106·1	71·6	188	155·9	105·1	248	205·6	138·7
9	7·5	5·0	69	57·2	38·6	129	106·9	72·1	189	156·7	105·7	249	206·4	139·2
10	8·3	5·6	70	58·0	39·1	130	107·8	72·7	190	157·5	106·2	250	207·3	139·8
11	9·1	6·2	71	58·9	39·7	131	108·6	73·3	191	158·3	106·8	251	208·1	140·4
12	9·9	6·7	72	59·7	40·3	132	109·4	73·8	192	159·2	107·4	252	208·9	140·9
13	10·8	7·3	73	60·5	40·8	133	110·3	74·4	193	160·0	107·9	253	209·7	141·5
14	11·6	7·8	74	61·3	41·4	134	111·1	74·9	194	160·8	108·5	254	210·6	142·0
15	12·4	8·4	75	62·2	41·9	135	111·9	75·5	195	161·7	109·0	255	211·4	142·6
16	13·3	8·9	76	63·0	42·5	136	112·7	76·1	196	162·5	109·6	256	212·2	143·2
17	14·1	9·5	77	63·8	43·1	137	113·6	76·6	197	163·3	110·2	257	213·1	143·7
18	14·9	10·1	78	64·7	43·6	138	114·4	77·2	198	164·1	110·7	258	213·9	144·3
19	15·8	10·6	79	65·5	44·2	139	115·2	77·7	199	165·0	111·3	259	214·7	144·8
20	16·6	11·2	80	66·3	44·7	140	116·1	78·3	200	165·8	111·8	260	215·5	145·4
21	17·4	11·7	81	67·2	45·3	141	116·9	78·8	201	166·6	112·4	261	216·4	145·9
22	18·2	12·3	82	68·0	45·9	142	117·7	79·4	202	167·5	113·0	262	217·2	146·5
23	19·1	12·9	83	68·8	46·4	143	118·6	80·0	203	168·3	113·5	263	218·0	147·1
24	19·9	13·4	84	69·6	47·0	144	119·4	80·5	204	169·1	114·1	264	218·9	147·6
25	20·7	14·0	85	70·5	47·5	145	120·2	81·1	205	170·0	114·6	265	219·7	148·2
26	21·6	14·5	86	71·3	48·1	146	121·0	81·6	206	170·8	115·2	266	220·5	148·7
27	22·4	15·1	87	72·1	48·6	147	121·9	82·2	207	171·6	115·8	267	221·4	149·3
28	23·2	15·7	88	73·0	49·2	148	122·7	82·8	208	172·4	116·3	268	222·2	149·9
29	24·0	16·2	89	73·8	49·8	149	123·5	83·3	209	173·3	116·9	269	223·0	150·4
30	24·9	16·8	90	74·6	50·3	150	124·4	83·9	210	174·1	117·4	270	223·8	151·0
31	25·7	17·3	91	75·4	50·9	151	125·2	84·4	211	174·9	118·0	271	224·7	151·5
32	26·5	17·9	92	76·3	51·4	152	126·0	85·0	212	175·8	118·5	272	225·5	152·1
33	27·4	18·5	93	77·1	52·0	153	126·8	85·6	213	176·6	119·1	273	226·3	152·7
34	28·2	19·0	94	77·9	52·6	154	127·7	86·1	214	177·4	119·7	274	227·2	153·2
35	29·0	19·6	95	78·8	53·1	155	128·5	86·7	215	178·2	120·2	275	228·0	153·8
36	29·8	20·1	96	79·6	53·7	156	129·3	87·2	216	179·1	120·8	276	228·8	154·3
37	30·7	20·7	97	80·4	54·2	157	130·2	87·8	217	179·9	121·3	277	229·6	154·9
38	31·5	21·2	98	81·2	54·8	158	131·0	88·4	218	180·7	121·9	278	230·5	155·5
39	32·3	21·8	99	82·1	55·4	159	131·8	88·9	219	181·6	122·5	279	231·3	156·0
40	33·2	22·4	100	82·9	55·9	160	132·6	89·5	220	182·4	123·0	280	232·1	156·6
41	34·0	22·9	101	83·7	56·5	161	133·5	90·0	221	183·2	123·6	281	233·0	157·1
42	34·8	23·5	102	84·6	57·0	162	134·3	90·6	222	184·0	124·1	282	233·8	157·7
43	35·6	24·0	103	85·4	57·6	163	135·1	91·1	223	184·9	124·7	283	234·6	158·3
44	36·5	24·6	104	86·2	58·2	164	136·0	91·7	224	185·7	125·3	284	235·4	158·8
45	37·3	25·2	105	87·0	58·7	165	136·8	92·3	225	186·5	125·8	285	236·3	159·4
46	38·1	25·7	106	87·9	59·3	166	137·6	92·8	226	187·4	126·4	286	237·1	159·9
47	39·0	26·3	107	88·7	59·8	167	138·4	93·4	227	188·2	126·9	287	237·9	160·5
48	39·8	26·8	108	89·5	60·4	168	139·3	93·9	228	189·0	127·5	288	238·8	161·0
49	40·6	27·4	109	90·4	61·0	169	140·1	94·5	229	189·8	128·1	289	239·6	161·6
50	41·5	28·0	110	91·2	61·5	170	140·9	95·1	230	190·7	128·6	290	240·4	162·2
51	42·3	28·5	111	92·0	62·1	171	141·8	95·6	231	191·5	129·2	291	241·2	162·7
52	43·1	29·1	112	92·9	62·6	172	142·6	96·2	232	192·3	129·7	292	242·1	163·3
53	43·9	29·6	113	93·7	63·2	173	143·4	96·7	233	193·2	130·3	293	242·9	163·8
54	44·8	30·2	114	94·5	63·7	174	144·3	97·3	234	194·0	130·9	294	243·7	164·4
55	45·6	30·8	115	95·3	64·3	175	145·1	97·9	235	194·8	131·4	295	244·6	165·0
56	46·4	31·3	116	96·2	64·9	176	145·9	98·4	236	195·7	132·0	296	245·4	165·5
57	47·3	31·9	117	97·0	65·4	177	146·7	99·0	237	196·5	132·5	297	246·2	166·1
58	48·1	32·4	118	97·8	66·0	178	147·6	99·5	238	197·3	133·1	298	247·1	166·6
59	48·9	33·0	119	98·7	66·5	179	148·4	100·1	239	198·1	133·6	299	247·9	167·2
60	49·7	33·6	120	99·5	67·1	180	149·2	100·7	240	199·0	134·2	300	248·7	167·8
Dist.	Dep.	D.Lat	Dist.	Dep.	D.Lat	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

56° — $3^h\ 44^m$

TRAVERSE TABLE TO DEGREES

34° 2h 16m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	249·5	168·3	361	299·3	201·9	421	349·0	235·4	481	398·8	269·0	541	448·5	302·5
302	250·4	168·9	362	300·1	202·4	422	349·9	236·0	482	399·6	269·5	542	449·4	303·1
303	251·2	169·4	363	300·9	203·0	423	350·7	236·5	483	400·4	270·1	543	450·2	303·6
304	252·0	170·0	364	301·8	203·5	424	351·5	237·1	484	401·3	270·6	544	451·0	304·2
305	252·9	170·6	365	302·6	204·1	425	352·3	237·7	485	402·1	271·2	545	451·8	304·8
306	253·7	171·1	366	303·4	204·7	426	353·2	238·2	486	402·9	271·8	546	452·6	305·3
307	254·5	171·7	367	304·3	205·2	427	354·0	238·8	487	403·8	272·3	547	453·5	305·9
308	255·3	172·2	368	305·1	205·8	428	354·8	239·3	488	404·6	272·8	548	454·3	306·4
309	256·2	172·8	369	305·9	206·3	429	355·7	239·9	489	405·4	273·4	549	455·2	307·0
310	257·0	173·3	370	306·7	206·9	430	356·5	240·4	490	406·2	274·0	550	456·0	307·5
311	257·8	173·9	371	307·6	207·5	431	357·3	241·0	491	407·1	274·6	551	456·8	308·1
312	258·7	174·5	372	308·4	208·0	432	358·1	241·6	492	407·9	275·1	552	457·6	308·7
313	259·5	175·0	373	309·2	208·6	433	359·0	242·1	493	408·7	275·7	553	458·4	309·2
314	260·3	175·6	374	310·1	209·1	434	359·8	242·7	494	409·5	276·2	554	459·3	309·8
315	261·2	176·1	375	310·9	209·7	435	360·6	243·2	495	410·4	276·8	555	460·1	310·3
316	262·0	176·7	376	311·7	210·3	436	361·5	243·8	496	411·2	277·4	556	460·9	310·9
317	262·8	177·3	377	312·6	210·8	437	362·3	244·4	497	412·0	277·9	557	461·7	311·5
318	263·7	177·8	378	313·4	211·4	438	363·1	244·9	498	412·8	278·4	558	462·6	312·0
319	264·5	178·4	379	314·2	211·9	439	364·0	245·5	499	413·7	279·0	559	463·4	312·6
320	265·3	178·9	380	315·0	212·5	440	364·8	246·0	500	414·5	279·6	560	464·2	313·1
321	266·1	179·5	381	315·9	213·0	441	365·6	246·6	501	415·3	280·1	561	465·1	313·7
322	267·0	180·1	382	316·7	213·6	442	366·4	247·2	502	416·2	280·7	562	465·9	314·3
323	267·8	180·6	383	317·5	214·2	443	367·3	247·7	503	417·0	281·3	563	466·8	314·8
324	268·6	181·2	384	318·4	214·7	444	368·1	248·3	504	417·8	281·8	564	467·6	315·4
325	269·5	181·7	385	319·2	215·3	445	368·9	248·8	505	418·6	282·4	565	468·4	315·9
326	270·3	182·3	386	320·0	215·8	446	369·8	249·4	506	419·4	282·9	566	469·2	316·5
327	271·1	182·9	387	320·8	216·4	447	370·6	250·0	507	420·3	283·5	567	470·1	317·1
328	271·9	183·4	388	321·7	217·0	448	371·4	250·5	508	421·1	284·1	568	470·9	317·6
329	272·8	184·0	389	322·5	217·5	449	372·2	251·1	509	421·9	284·6	569	471·7	318·2
330	273·6	184·5	390	323·3	218·1	450	373·1	251·6	510	422·8	285·2	570	472·6	318·7
331	274·4	185·1	391	324·2	218·6	451	373·9	252·2	511	423·6	285·8	571	473·4	319·3
332	275·2	185·6	392	325·0	219·2	452	374·7	252·8	512	424·4	286·3	572	474·2	319·9
333	276·1	186·2	393	325·8	219·8	453	375·6	253·3	513	425·3	286·9	573	475·0	320·4
334	276·9	186·8	394	326·6	220·3	454	376·4	253·9	514	426·1	287·4	574	475·9	321·0
335	277·7	187·3	395	327·5	220·9	455	377·2	254·4	515	426·9	288·0	575	476·7	321·5
336	278·6	187·9	396	328·3	221·4	456	378·0	255·0	516	427·8	288·5	576	477·5	322·1
337	279·4	188·4	397	329·1	222·0	457	378·9	255·5	517	428·6	289·1	577	478·3	322·7
338	280·2	189·0	398	330·0	222·6	458	379·7	256·1	518	429·4	289·6	578	479·2	323·2
339	281·0	189·6	399	330·8	223·1	459	380·5	256·7	519	430·3	290·2	579	480·0	323·8
340	281·9	190·1	400	331·6	223·7	460	381·3	257·2	520	431·1	290·8	580	480·8	324·3
341	282·7	190·7	401	332·4	224·2	461	382·2	257·8	521	431·9	291·3	581	481·6	324·9
342	283·5	191·2	402	333·3	224·8	462	383·0	258·3	522	432·8	291·9	582	482·5	325·4
343	284·4	191·8	403	334·1	225·4	463	383·8	258·9	523	433·6	292·5	583	483·3	326·0
344	285·2	192·4	404	334·9	225·9	464	384·7	259·5	524	434·4	293·0	584	484·1	326·6
345	286·0	192·9	405	335·8	226·5	465	385·5	260·0	525	435·3	293·6	585	485·0	327·2
346	286·9	193·5	406	336·6	227·0	466	386·3	260·6	526	436·1	294·1	586	485·8	327·7
347	287·7	194·0	407	337·4	227·6	467	387·2	261·1	527	436·9	294·7	587	486·6	328·2
348	288·5	194·6	408	338·3	228·1	468	388·0	261·7	528	437·8	295·3	588	487·5	328·8
349	289·3	195·2	409	339·1	228·7	469	388·8	262·3	529	438·6	295·8	589	488·3	329·4
350	290·2	195·7	410	339·9	229·3	470	389·7	262·8	530	439·4	296·4	590	489·2	329·9
351	291·0	196·3	411	340·7	229·8	471	390·5	263·4	531	440·3	296·9	591	490·0	330·5
352	291·8	196·8	412	341·6	230·4	472	391·3	263·9	532	441·1	297·4	592	490·8	331·0
353	292·7	197·4	413	342·4	230·9	473	392·1	264·5	533	441·9	298·0	593	491·6	331·6
354	293·5	198·0	414	343·2	231·5	474	393·0	265·0	534	442·7	298·6	594	492·5	332·2
355	294·3	198·5	415	344·1	232·1	475	393·8	265·6	535	443·6	299·1	595	493·3	332·7
356	295·1	199·1	416	344·9	232·6	476	394·6	266·2	536	444·4	299·7	596	494·1	333·3
357	296·0	199·6	417	345·7	233·2	477	395·5	266·7	537	445·3	300·2	597	494·9	333·8
358	296·8	200·2	418	346·5	233·7	478	396·3	267·3	538	446·1	300·8	598	495·8	334·4
359	297·6	200·7	419	347·4	234·3	479	397·1	267·9	539	446·9	301·4	599	496·6	334·9
360	298·5	201·3	420	348·2	234·9	480	397·9	268·4	540	447·7	302·0	600	497·4	335·5
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

56° 3h 44m

TRAVERSE TABLE TO DEGREES

35° — 2h 20m

Dist.	D.Lat	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·8	0·6	61	50·0	35·0	121	99·1	69·4	181	148·3	103·8	241	197·4	138·2
2	1·6	1·1	62	50·8	35·6	122	99·9	70·0	182	149·1	104·4	242	198·2	138·8
3	2·5	1·7	63	51·6	36·1	123	100·8	70·5	183	149·9	105·0	243	199·1	139·4
4	3·3	2·3	64	52·4	36·7	124	101·6	71·1	184	150·7	105·5	244	199·9	140·0
5	4·1	2·9	65	53·2	37·3	125	102·4	71·7	185	151·5	106·1	245	200·7	140·5
6	4·9	3·4	66	54·1	37·9	126	103·2	72·3	186	152·4	106·7	246	201·5	141·1
7	5·7	4·0	67	54·9	38·4	127	104·0	72·8	187	153·2	107·3	247	202·3	141·7
8	6·6	4·6	68	55·7	39·0	128	104·9	73·4	188	154·0	107·8	248	203·1	142·2
9	7·4	5·2	69	56·5	39·6	129	105·7	74·0	189	154·8	108·4	249	204·0	142·8
10	8·2	5·7	70	57·3	40·2	130	106·5	74·6	190	155·6	109·0	250	204·8	143·4
11	9·0	6·3	71	58·2	40·7	131	107·3	75·1	191	156·5	109·6	251	205·6	144·0
12	9·8	6·9	72	59·0	41·3	132	108·1	75·7	192	157·3	110·1	252	206·4	144·5
13	10·6	7·5	73	59·8	41·9	133	108·9	76·3	193	158·1	110·7	253	207·2	145·1
14	11·5	8·0	74	60·6	42·4	134	109·8	76·9	194	158·9	111·3	254	208·1	145·7
15	12·3	8·6	75	61·4	43·0	135	110·6	77·4	195	159·7	111·8	255	208·9	146·3
16	13·1	9·2	76	62·3	43·6	136	111·4	78·0	196	160·6	112·4	256	209·7	146·8
17	13·9	9·8	77	63·1	44·2	137	112·2	78·6	197	161·4	113·0	257	210·5	147·4
18	14·7	10·3	78	63·9	44·7	138	113·0	79·2	198	162·2	113·6	258	211·3	148·0
19	15·6	10·9	79	64·7	45·3	139	113·9	79·7	199	163·0	114·1	259	212·2	148·6
20	16·4	11·5	80	65·5	45·9	140	114·7	80·3	200	163·8	114·7	260	213·0	149·1
21	17·2	12·0	81	66·4	46·5	141	115·5	80·9	201	164·6	115·3	261	213·8	149·7
22	18·0	12·6	82	67·2	47·0	142	116·3	81·4	202	165·5	115·9	262	214·6	150·3
23	18·8	13·2	83	68·0	47·6	143	117·1	82·0	203	166·3	116·4	263	215·4	150·9
24	19·7	13·8	84	68·8	48·2	144	118·0	82·6	204	167·1	117·0	264	216·3	151·4
25	20·5	14·3	85	69·6	48·8	145	118·8	83·2	205	167·9	117·6	265	217·1	152·0
26	21·3	14·9	86	70·4	49·3	146	119·6	83·7	206	168·7	118·2	266	217·9	152·6
27	22·1	15·5	87	71·3	49·9	147	120·4	84·3	207	169·6	118·7	267	218·7	153·1
28	22·9	16·1	88	72·1	50·5	148	121·2	84·9	208	170·4	119·3	268	219·5	153·7
29	23·8	16·6	89	72·9	51·0	149	122·1	85·5	209	171·2	119·9	269	220·4	154·3
30	24·6	17·2	90	73·7	51·6	150	122·9	86·0	210	172·0	120·5	270	221·2	154·9
31	25·4	17·8	91	74·5	52·2	151	123·7	86·6	211	172·8	121·0	271	222·0	155·4
32	26·2	18·4	92	75·4	52·8	152	124·5	87·2	212	173·7	121·6	272	222·8	156·0
33	27·0	18·9	93	76·2	53·3	153	125·3	87·8	213	174·5	122·2	273	223·6	156·6
34	27·9	19·5	94	77·0	53·9	154	126·1	88·3	214	175·3	122·7	274	224·4	157·2
35	28·7	20·1	95	77·8	54·5	155	127·0	88·9	215	176·1	123·3	275	225·3	157·7
36	29·5	20·6	96	78·6	55·1	156	127·8	89·5	216	176·9	123·9	276	226·1	158·3
37	30·3	21·2	97	79·5	55·6	157	128·6	90·1	217	177·8	124·5	277	226·9	158·9
38	31·1	21·8	98	80·3	56·2	158	129·4	90·6	218	178·6	125·0	278	227·7	159·5
39	31·9	22·4	99	81·1	56·8	159	130·2	91·2	219	179·4	125·6	279	228·5	160·0
40	32·8	22·9	100	81·9	57·4	160	131·1	91·8	220	180·2	126·2	280	229·4	160·6
41	33·6	23·5	101	82·7	57·9	161	131·9	92·3	221	181·0	126·8	281	230·2	161·2
42	34·4	24·1	102	83·6	58·5	162	132·7	92·9	222	181·9	127·3	282	231·0	161·7
43	35·2	24·7	103	84·4	59·1	163	133·5	93·5	223	182·7	127·9	283	231·8	162·3
44	36·0	25·2	104	85·2	59·7	164	134·3	94·1	224	183·5	128·5	284	232·6	162·9
45	36·9	25·8	105	86·0	60·2	165	135·2	94·6	225	184·3	129·1	285	233·5	163·5
46	37·7	26·4	106	86·8	60·8	166	136·0	95·2	226	185·1	129·6	286	234·3	164·0
47	38·5	27·0	107	87·6	61·4	167	136·8	95·8	227	185·9	130·2	287	235·1	164·6
48	39·3	27·5	108	88·5	61·9	168	137·6	96·4	228	186·8	130·8	288	235·9	165·2
49	40·1	28·1	109	89·3	62·5	169	138·4	96·9	229	187·6	131·3	289	236·7	165·8
50	41·0	28·7	110	90·1	63·1	170	139·3	97·5	230	188·4	131·9	290	237·6	166·3
51	41·8	29·3	111	90·9	63·7	171	140·1	98·1	231	189·2	132·5	291	238·4	166·9
52	42·6	29·8	112	91·7	64·2	172	140·9	98·7	232	190·0	133·1	292	239·2	167·5
53	43·4	30·4	113	92·6	64·8	173	141·7	99·2	233	190·9	133·6	293	240·0	168·1
54	44·2	31·0	114	93·4	65·4	174	142·5	99·8	234	191·7	134·2	294	240·8	168·6
55	45·1	31·5	115	94·2	66·0	175	143·4	100·4	235	192·5	134·8	295	241·6	169·2
56	45·9	32·1	116	95·0	66·5	176	144·2	100·9	236	193·3	135·4	296	242·5	169·8
57	46·7	32·7	117	95·8	67·1	177	145·0	101·5	237	194·1	135·9	297	243·3	170·4
58	47·5	33·3	118	96·7	67·7	178	145·8	102·1	238	195·0	136·5	298	244·1	170·9
59	48·3	33·8	119	97·5	68·3	179	146·6	102·7	239	195·8	137·1	299	244·9	171·5
60	49·1	34·4	120	98·3	68·8	180	147·4	103·2	240	196·6	137·7	300	245·7	172·1
Dist.	Dep.	D.Lat	Dist.	Dep.	D.Lat	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

55° — 3h 40m

TRAVERSE TABLE TO DEGREES

35° 2h 20m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	246.6	172.6	361	295.7	207.0	421	344.9	241.5	481	394.0	275.9	541	443.2	310.3
302	247.4	173.2	362	296.5	207.6	422	345.7	242.0	482	394.8	276.4	542	444.0	310.9
303	248.2	173.8	363	297.4	208.2	423	346.5	242.6	483	395.7	277.0	543	444.8	311.4
304	249.0	174.3	364	298.2	208.8	424	347.3	243.2	484	396.5	277.6	544	445.6	312.0
305	249.9	174.9	365	299.0	209.3	425	348.1	243.8	485	397.3	278.2	545	446.4	312.6
306	250.7	175.5	366	299.8	209.9	426	349.0	244.3	486	398.1	278.7	546	447.3	313.2
307	251.5	176.1	367	300.6	210.5	427	349.8	244.9	487	398.9	279.3	547	448.1	313.7
308	252.3	176.6	368	301.5	211.1	428	350.6	245.5	488	399.8	279.9	548	448.9	314.3
309	253.1	177.2	369	302.3	211.6	429	351.4	246.0	489	400.6	280.5	549	449.7	314.9
310	253.9	177.8	370	303.1	212.2	430	352.2	246.6	490	401.4	281.0	550	450.5	315.4
311	254.8	178.4	371	303.9	212.8	431	353.1	247.2	491	402.2	281.6	551	451.4	316.0
312	255.6	178.9	372	304.7	213.4	432	353.9	247.8	492	403.0	282.2	552	452.2	316.6
313	256.4	179.5	373	305.6	213.9	433	354.7	248.3	493	403.9	282.8	553	453.0	317.2
314	257.2	180.1	374	306.4	214.5	434	355.5	248.9	494	404.7	283.3	554	453.8	317.7
315	258.0	180.7	375	307.2	215.1	435	356.3	249.5	495	405.5	283.9	555	454.6	318.3
316	258.9	181.2	376	308.0	215.6	436	357.2	250.1	496	406.3	284.5	556	455.5	318.9
317	259.7	181.8	377	308.8	216.2	437	358.0	250.6	497	407.1	285.1	557	456.3	319.5
318	260.5	182.4	378	309.6	216.8	438	358.8	251.2	498	408.0	285.6	558	457.1	320.0
319	261.3	183.0	379	310.5	217.4	439	359.6	251.8	499	408.8	286.2	559	457.9	320.6
320	262.1	183.5	380	311.3	217.9	440	360.4	252.4	500	409.6	286.8	560	458.7	321.2
321	263.0	184.1	381	312.1	218.5	441	361.3	252.9	501	410.4	287.4	561	459.6	321.8
322	263.8	184.7	382	312.9	219.1	442	362.1	253.5	502	411.2	287.9	562	460.4	322.3
323	264.6	185.2	383	313.7	219.7	443	362.9	254.1	503	412.1	288.5	563	461.2	322.9
324	265.4	185.8	384	314.6	220.2	444	363.7	254.7	504	412.9	289.1	564	462.0	323.5
325	266.2	186.4	385	315.4	220.8	445	364.5	255.2	505	413.7	289.7	565	462.8	324.1
326	267.1	187.0	386	316.2	221.4	446	365.4	255.8	506	414.5	290.2	566	463.7	324.6
327	267.9	187.5	387	317.0	222.0	447	366.2	256.4	507	415.3	290.8	567	464.5	325.2
328	268.7	188.1	388	317.8	222.5	448	367.0	256.9	508	416.1	291.4	568	465.3	325.8
329	269.5	188.7	389	318.7	223.1	449	367.8	257.5	509	417.0	291.9	569	466.1	326.4
330	270.3	189.3	390	319.5	223.7	450	368.6	258.1	510	417.8	292.5	570	466.9	326.9
331	271.1	189.8	391	320.3	224.3	451	369.4	258.7	511	418.6	293.1	571	467.8	327.5
332	272.0	190.4	392	321.1	224.8	452	370.3	259.2	512	419.4	293.7	572	468.6	328.1
333	272.8	191.0	393	321.9	225.4	453	371.1	259.8	513	420.2	294.2	573	469.4	328.7
334	273.6	191.6	394	322.8	226.0	454	371.9	260.4	514	421.1	294.8	574	470.2	329.2
335	274.4	192.1	395	323.6	226.5	455	372.7	261.0	515	421.9	295.4	575	471.0	329.8
336	275.2	192.7	396	324.4	227.1	456	373.5	261.5	516	422.7	296.0	576	471.9	330.4
337	276.1	193.3	397	325.2	227.7	457	374.4	262.1	517	423.5	296.5	577	472.7	331.0
338	276.9	193.9	398	326.0	228.3	458	375.2	262.7	518	424.3	297.1	578	473.5	331.5
339	277.7	194.4	399	326.9	228.8	459	376.0	263.3	519	425.2	297.7	579	474.3	332.1
340	278.5	195.0	400	327.7	229.4	460	376.8	263.8	520	426.0	298.3	580	475.1	332.7
341	279.3	195.6	401	328.5	230.0	461	377.6	264.4	521	426.8	298.8	581	476.0	333.3
342	280.2	196.1	402	329.3	230.6	462	378.5	265.0	522	427.6	299.4	582	476.8	333.8
343	281.0	196.7	403	330.1	231.1	463	379.3	265.5	523	428.4	300.0	583	477.6	334.4
344	281.8	197.3	404	330.9	231.7	464	380.1	266.1	524	429.3	300.5	584	478.4	335.0
345	282.6	197.9	405	331.8	232.3	465	380.9	266.7	525	430.1	301.1	585	479.2	335.6
346	283.4	198.4	406	332.6	232.9	466	381.7	267.3	526	430.9	301.7	586	480.1	336.1
347	284.3	199.0	407	333.4	233.4	467	382.6	267.8	527	431.7	302.3	587	480.9	336.7
348	285.1	199.6	408	334.2	234.0	468	383.4	268.4	528	432.5	302.8	588	481.7	337.3
349	285.9	200.2	409	335.0	234.6	469	384.2	269.0	529	433.4	303.4	589	482.5	337.9
350	286.7	200.7	410	335.9	235.1	470	385.0	269.6	530	434.2	304.0	590	483.3	338.4
351	287.5	201.3	411	336.7	235.7	471	385.8	270.1	531	435.0	304.5	591	484.2	339.0
352	288.3	201.9	412	337.5	236.3	472	386.6	270.7	532	435.8	305.1	592	485.0	339.6
353	289.2	202.5	413	338.3	236.9	473	387.5	271.3	533	436.6	305.7	593	485.8	340.2
354	290.0	203.0	414	339.1	237.4	474	388.3	271.9	534	437.5	306.3	594	486.6	340.7
355	290.8	203.6	415	340.0	238.0	475	389.1	272.4	535	438.3	306.8	595	487.4	341.3
356	291.6	204.2	416	340.8	238.6	476	389.9	273.0	536	439.1	307.4	596	488.3	341.9
357	292.4	204.7	417	341.6	239.2	477	390.7	273.6	537	439.9	308.0	597	489.1	342.5
358	293.3	205.3	418	342.4	239.7	478	391.6	274.2	538	440.7	308.6	598	489.9	343.0
359	294.1	205.9	419	343.2	240.3	479	392.4	274.7	539	441.5	309.1	599	490.7	343.6
360	294.9	206.5	420	344.1	240.9	480	393.2	275.3	540	442.3	309.7	600	491.5	344.1
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

55° 3h 40m

TRAVERSE TABLE TO DEGREES

36° 2h 24m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·8	0·6	61	49·4	35·9	121	97·9	71·1	181	146·4	106·4	241	195·0	141·7
2	1·6	1·2	62	50·2	36·4	122	98·7	71·7	182	147·2	107·0	242	195·8	142·2
3	2·4	1·8	63	51·0	37·0	123	99·5	72·3	183	148·1	107·6	243	196·6	142·8
4	3·2	2·4	64	51·8	37·6	124	100·3	72·9	184	148·9	108·2	244	197·4	143·4
5	4·0	2·9	65	52·6	38·2	125	101·1	73·5	185	149·7	108·7	245	198·2	144·0
6	4·9	3·5	66	53·4	38·8	126	101·9	74·1	186	150·5	109·3	246	199·0	144·6
7	5·7	4·1	67	54·2	39·4	127	102·7	74·6	187	151·3	109·9	247	199·8	145·2
8	6·5	4·7	68	55·0	40·0	128	103·6	75·2	188	152·1	110·5	248	200·6	145·8
9	7·3	5·3	69	55·8	40·6	129	104·4	75·8	189	152·9	111·1	249	201·4	146·4
10	8·1	5·9	70	56·6	41·1	130	105·2	76·4	190	153·7	111·7	250	202·3	146·9
11	8·9	6·5	71	57·4	41·7	131	106·0	77·0	191	154·5	112·3	251	203·1	147·5
12	9·7	7·1	72	58·2	42·3	132	106·8	77·6	192	155·3	112·9	252	203·9	148·1
13	10·5	7·6	73	59·1	42·9	133	107·6	78·2	193	156·1	113·4	253	204·7	148·7
14	11·3	8·2	74	59·9	43·5	134	108·4	78·8	194	156·9	114·0	254	205·5	149·3
15	12·1	8·8	75	60·7	44·1	135	109·2	79·4	195	157·8	114·6	255	206·3	149·9
16	12·9	9·4	76	61·5	44·7	136	110·0	79·9	196	158·6	115·2	256	207·1	150·5
17	13·8	10·0	77	62·3	45·3	137	110·8	80·5	197	159·4	115·8	257	207·9	151·1
18	14·6	10·6	78	63·1	45·8	138	111·6	81·1	198	160·2	116·4	258	208·7	151·6
19	15·4	11·2	79	63·9	46·4	139	112·5	81·7	199	161·0	117·0	259	209·5	152·2
20	16·2	11·8	80	64·7	47·0	140	113·3	82·3	200	161·8	117·6	260	210·3	152·8
21	17·0	12·3	81	65·5	47·6	141	114·1	82·9	201	162·6	118·1	261	211·2	153·4
22	17·8	12·9	82	66·3	48·2	142	114·9	83·5	202	163·4	118·7	262	212·0	154·0
23	18·6	13·5	83	67·1	48·8	143	115·7	84·1	203	164·2	119·3	263	212·8	154·6
24	19·4	14·1	84	68·0	49·4	144	116·5	84·6	204	165·0	119·9	264	213·6	155·2
25	20·2	14·7	85	68·8	50·0	145	117·3	85·2	205	165·8	120·5	265	214·4	155·8
26	21·0	15·3	86	69·6	50·5	146	118·1	85·8	206	166·7	121·1	266	215·2	156·4
27	21·8	15·9	87	70·4	51·1	147	118·9	86·4	207	167·5	121·7	267	216·0	156·9
28	22·7	16·5	88	71·2	51·7	148	119·7	87·0	208	168·3	122·3	268	216·8	157·5
29	23·5	17·0	89	72·0	52·3	149	120·5	87·6	209	169·1	122·8	269	217·6	158·1
30	24·3	17·6	90	72·8	52·9	150	121·4	88·2	210	169·9	123·4	270	218·4	158·7
31	25·1	18·2	91	73·6	53·5	151	122·2	88·8	211	170·7	124·0	271	219·2	159·3
32	25·9	18·8	92	74·4	54·1	152	123·0	89·3	212	171·5	124·6	272	220·1	159·9
33	26·7	19·4	93	75·2	54·7	153	123·8	89·9	213	172·3	125·2	273	220·9	160·5
34	27·5	20·0	94	76·0	55·3	154	124·6	90·5	214	173·1	125·8	274	221·7	161·1
35	28·3	20·6	95	76·9	55·8	155	125·4	91·1	215	173·9	126·4	275	222·5	161·6
36	29·1	21·2	96	77·7	56·4	156	126·2	91·7	216	174·7	127·0	276	223·3	162·2
37	29·9	21·7	97	78·5	57·0	157	127·0	92·3	217	175·6	127·5	277	224·1	162·8
38	30·7	22·3	98	79·3	57·6	158	127·8	92·9	218	176·4	128·1	278	224·9	163·4
39	31·6	22·9	99	80·1	58·2	159	128·6	93·5	219	177·2	128·7	279	225·7	164·0
40	32·4	23·5	100	80·9	58·8	160	129·4	94·0	220	178·0	129·3	280	226·5	164·6
41	33·2	24·1	101	81·7	59·4	161	130·3	94·6	221	178·8	129·9	281	227·3	165·2
42	34·0	24·7	102	82·5	60·0	162	131·1	95·2	222	179·6	130·5	282	228·1	165·8
43	34·8	25·3	103	83·3	60·5	163	131·9	95·8	223	180·4	131·1	283	229·0	166·3
44	35·6	25·9	104	84·1	61·1	164	132·7	96·4	224	181·2	131·7	284	229·8	166·9
45	36·4	26·5	105	84·9	61·7	165	133·5	97·0	225	182·0	132·3	285	230·6	167·5
46	37·2	27·0	106	85·8	62·3	166	134·3	97·6	226	182·8	132·8	286	231·4	168·1
47	38·0	27·6	107	86·6	62·9	167	135·1	98·2	227	183·6	133·4	287	232·2	168·7
48	38·8	28·2	108	87·4	63·5	168	135·9	98·7	228	184·5	134·0	288	233·0	169·3
49	39·6	28·8	109	88·2	64·1	169	136·7	99·3	229	185·3	134·6	289	233·8	169·9
50	40·5	29·4	110	89·0	64·7	170	137·5	99·9	230	186·1	135·2	290	234·6	170·5
51	41·3	30·0	111	89·8	65·2	171	138·3	100·5	231	186·9	135·8	291	235·4	171·0
52	42·1	30·6	112	90·6	65·8	172	139·2	101·1	232	187·7	136·4	292	236·2	171·6
53	42·9	31·2	113	91·4	66·4	173	140·0	101·7	233	188·5	137·0	293	237·0	172·2
54	43·7	31·7	114	92·2	67·0	174	140·8	102·3	234	189·3	137·5	294	237·9	172·8
55	44·5	32·3	115	93·0	67·6	175	141·6	102·9	235	190·1	138·1	295	238·7	173·4
56	45·3	32·9	116	93·8	68·2	176	142·4	103·5	236	190·9	138·7	296	239·5	174·0
57	46·1	33·5	117	94·7	68·8	177	143·2	104·0	237	191·7	139·3	297	240·3	174·6
58	46·9	34·1	118	95·5	69·4	178	144·0	104·6	238	192·5	139·9	298	241·1	175·2
59	47·7	34·7	119	96·3	69·9	179	144·8	105·2	239	193·4	140·5	299	241·9	175·7
60	48·5	35·3	120	97·1	70·5	180	145·6	105·8	240	194·2	141·1	300	242·7	176·3
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

54° 3h 36m

TRAVERSE TABLE TO DEGREES

36° 2h 24m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	243·5	176·9	361	292·1	212·2	421	340·6	247·5	481	389·1	282·7	541	437·7	318·0
302	244·3	177·5	362	292·9	212·8	422	341·4	248·1	482	390·0	283·3	542	438·5	318·6
303	245·1	178·1	363	293·7	213·4	423	342·2	248·6	483	390·8	283·9	543	439·3	319·1
304	246·0	178·7	364	294·5	214·0	424	343·0	249·2	484	391·6	284·5	544	440·2	319·7
305	246·8	179·3	365	295·3	214·6	425	343·8	249·8	485	392·4	285·1	545	441·0	320·3
306	247·6	179·9	366	296·1	215·1	426	344·7	250·4	486	393·2	285·6	546	441·8	320·9
307	248·4	180·5	367	296·9	215·7	427	345·5	251·0	487	394·0	286·2	547	442·6	321·5
308	249·2	181·1	368	297·7	216·3	428	346·3	251·6	488	394·8	286·8	548	443·4	322·1
309	250·0	181·6	369	298·5	216·9	429	347·1	252·2	489	395·6	287·4	549	444·2	322·7
310	250·8	182·2	370	299·3	217·5	430	347·9	252·8	490	396·4	288·0	550	445·0	323·3
311	251·6	182·8	371	300·2	218·1	431	348·7	253·3	491	397·3	288·6	551	445·8	323·8
312	252·4	183·4	372	301·0	218·7	432	349·5	253·9	492	398·1	289·2	552	446·6	324·4
313	253·2	184·0	373	301·8	219·3	433	350·3	254·5	493	398·9	289·8	553	447·4	325·0
314	254·0	184·6	374	302·6	219·8	434	351·1	255·1	494	399·7	290·3	554	448·2	325·6
315	254·9	185·2	375	303·4	220·4	435	351·9	255·7	495	400·5	290·9	555	449·0	326·2
316	255·7	185·8	376	304·2	221·0	436	352·7	256·3	496	401·3	291·5	556	449·8	326·8
317	256·5	186·4	377	305·0	221·6	437	353·6	256·9	497	402·1	292·1	557	450·7	327·4
318	257·3	186·9	378	305·8	222·2	438	354·4	257·5	498	402·9	292·7	558	451·5	328·0
319	258·1	187·5	379	306·6	222·8	439	355·2	258·0	499	403·7	293·3	559	452·3	328·5
320	258·9	188·1	380	307·4	223·4	440	356·0	258·6	500	404·5	293·9	560	453·1	329·1
321	259·7	188·7	381	308·2	224·0	441	356·8	259·2	501	405·3	294·5	561	453·9	329·7
322	260·5	189·3	382	309·1	224·5	442	357·6	259·8	502	406·1	295·0	562	454·7	330·3
323	261·3	189·9	383	309·9	225·1	443	358·4	260·4	503	407·0	295·6	563	455·5	330·9
324	262·1	190·5	384	310·7	225·7	444	359·2	261·0	504	407·8	296·2	564	456·3	331·5
325	262·9	191·0	385	311·5	226·3	445	360·0	261·6	505	408·6	296·8	565	457·1	332·1
326	263·7	191·6	386	312·3	226·9	446	360·8	262·2	506	409·4	297·4	566	457·9	332·7
327	264·6	192·2	387	313·1	227·5	447	361·6	262·8	507	410·2	298·0	567	458·7	333·3
328	265·4	192·8	388	313·9	228·1	448	362·4	263·3	508	411·0	298·6	568	459·5	333·8
329	266·2	193·4	389	314·7	228·7	449	363·3	263·9	509	411·8	299·2	569	460·3	334·4
330	267·0	194·0	390	315·5	229·2	450	364·1	264·5	510	412·6	299·8	570	461·1	335·0
331	267·8	194·6	391	316·3	229·8	451	364·9	265·1	511	413·4	300·3	571	462·0	335·6
332	268·6	195·2	392	317·1	230·4	452	365·7	265·7	512	414·2	300·9	572	462·8	336·2
333	269·4	195·7	393	318·0	231·0	453	366·5	266·3	513	415·1	301·5	573	463·6	336·8
334	270·2	196·3	394	318·8	231·6	454	367·3	266·9	514	415·9	302·1	574	464·4	337·4
335	271·0	196·9	395	319·6	232·2	455	368·1	267·5	515	416·7	302·7	575	465·2	338·0
336	271·8	197·5	396	320·4	232·8	456	368·9	268·0	516	417·5	303·3	576	466·0	338·5
337	272·6	198·1	397	321·2	233·4	457	369·7	268·6	517	418·3	303·9	577	466·8	339·1
338	273·5	198·7	398	322·0	233·9	458	370·5	269·2	518	419·1	304·4	578	467·6	339·7
339	274·3	199·3	399	322·8	234·5	459	371·3	269·8	519	419·9	305·0	579	468·4	340·3
340	275·1	199·9	400	323·6	235·1	460	372·2	270·4	520	420·7	305·6	580	469·3	340·9
341	275·9	200·4	401	324·4	235·7	461	373·0	271·0	521	421·5	306·2	581	470·1	341·5
342	276·7	201·0	402	325·2	236·3	462	373·8	271·6	522	422·3	306·8	582	470·9	342·1
343	277·5	201·6	403	326·0	236·9	463	374·6	272·2	523	423·1	307·4	583	471·7	342·7
344	278·3	202·2	404	326·9	237·5	464	375·4	272·7	524	423·9	308·0	584	472·5	343·2
345	279·1	202·8	405	327·7	238·1	465	376·2	273·3	525	424·7	308·6	585	473·3	343·8
346	279·9	203·4	406	328·5	238·7	466	377·0	273·9	526	425·5	309·2	586	474·1	344·4
347	280·7	204·0	407	329·3	239·2	467	377·8	274·5	527	426·4	309·7	587	474·9	345·0
348	281·5	204·6	408	330·1	239·8	468	378·6	275·1	528	427·2	310·3	588	475·7	345·6
349	282·4	205·1	409	330·9	240·4	469	379·4	275·7	529	428·0	310·9	589	476·5	346·2
350	283·2	205·7	410	331·7	241·0	470	380·2	276·3	530	428·8	311·5	590	477·3	346·8
351	284·0	206·3	411	332·5	241·6	471	381·1	276·9	531	429·6	312·1	591	478·2	347·4
352	284·8	206·9	412	333·3	242·2	472	381·9	277·4	532	430·4	312·7	592	479·0	347·9
353	285·6	207·5	413	334·1	242·8	473	382·7	278·0	533	431·2	313·3	593	479·8	348·5
354	286·4	208·1	414	334·9	243·4	474	383·5	278·6	534	432·0	313·9	594	480·6	349·1
355	287·2	208·7	415	335·8	243·9	475	384·3	279·2	535	432·9	314·4	595	481·4	349·7
356	288·0	209·3	416	336·6	244·5	476	385·1	279·8	536	433·7	315·0	596	482·2	350·3
357	288·8	209·8	417	337·4	245·1	477	385·9	280·4	537	434·5	315·6	597	483·0	350·9
358	289·6	210·4	418	338·2	245·7	478	386·7	281·0	538	435·3	316·2	598	483·8	351·5
359	290·4	211·0	419	339·0	246·3	479	387·5	281·6	539	436·1	316·8	599	484·6	352·1
360	291·3	211·6	420	339·8	246·9	480	388·3	282·1	540	436·9	317·4	600	485·4	352·7
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

51° 3h 36m

TRAVERSE TABLE TO DEGREES

37°														2h 28m
Dist.	D.Lat	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·8	0·6	61	48·7	36·7	121	96·6	72·8	181	144·6	108·9	241	192·5	145·0
2	1·6	1·2	62	49·5	37·3	122	97·4	73·4	182	145·4	109·5	242	193·3	145·6
3	2·4	1·8	63	50·3	37·9	123	98·2	74·0	183	146·2	110·1	243	194·1	146·2
4	3·2	2·4	64	51·1	38·5	124	99·0	74·6	184	146·9	110·7	244	194·9	146·8
5	4·0	3·0	65	51·9	39·1	125	99·8	75·2	185	147·7	111·3	245	195·7	147·4
6	4·8	3·6	66	52·7	39·7	126	100·6	75·8	186	148·5	111·9	246	196·5	148·0
7	5·6	4·2	67	53·5	40·3	127	101·4	76·4	187	149·3	112·5	247	197·3	148·6
8	6·4	4·8	68	54·3	40·9	128	102·2	77·0	188	150·1	113·1	248	198·1	149·3
9	7·2	5·4	69	55·1	41·5	129	103·0	77·6	189	150·9	113·7	249	198·9	149·9
10	8·0	6·0	70	55·9	42·1	130	103·8	78·2	190	151·7	114·3	250	199·7	150·5
11	8·8	6·6	71	56·7	42·7	131	104·6	78·8	191	152·5	114·9	251	200·5	151·1
12	9·6	7·2	72	57·5	43·3	132	105·4	79·4	192	153·3	115·5	252	201·3	151·7
13	10·4	7·8	73	58·3	43·9	133	106·2	80·0	193	154·1	116·2	253	202·1	152·3
14	11·2	8·4	74	59·1	44·5	134	107·0	80·6	194	154·9	116·8	254	202·9	152·9
15	12·0	9·0	75	59·9	45·1	135	107·8	81·2	195	155·7	117·4	255	203·7	153·5
16	12·8	9·6	76	60·7	45·7	136	108·6	81·8	196	156·5	118·0	256	204·5	154·1
17	13·6	10·2	77	61·5	46·3	137	109·4	82·4	197	157·3	118·6	257	205·2	154·7
18	14·4	10·8	78	62·3	46·9	138	110·2	83·1	198	158·1	119·2	258	206·0	155·3
19	15·2	11·4	79	63·1	47·5	139	111·0	83·7	199	158·9	119·8	259	206·8	155·9
20	16·0	12·0	80	63·9	48·1	140	111·8	84·3	200	159·7	120·4	260	207·6	156·5
21	16·8	12·6	81	64·7	48·7	141	112·6	84·9	201	160·5	121·0	261	208·4	157·1
22	17·6	13·2	82	65·5	49·3	142	113·4	85·5	202	161·3	121·6	262	209·2	157·7
23	18·4	13·8	83	66·3	50·0	143	114·2	86·1	203	162·1	122·2	263	210·0	158·3
24	19·2	14·4	84	67·1	50·6	144	115·0	86·7	204	162·9	122·8	264	210·8	158·9
25	20·0	15·0	85	67·9	51·2	145	115·8	87·3	205	163·7	123·4	265	211·6	159·5
26	20·8	15·6	86	68·7	51·8	146	116·6	87·9	206	164·5	124·0	266	212·4	160·1
27	21·6	16·2	87	69·5	52·4	147	117·4	88·5	207	165·3	124·6	267	213·2	160·7
28	22·4	16·9	88	70·3	53·0	148	118·2	89·1	208	166·1	125·2	268	214·0	161·3
29	23·2	17·5	89	71·1	53·6	149	119·0	89·7	209	166·9	125·8	269	214·8	161·9
30	24·0	18·1	90	71·9	54·2	150	119·8	90·3	210	167·7	126·4	270	215·6	162·5
31	24·8	18·7	91	72·7	54·8	151	120·6	90·9	211	168·5	127·0	271	216·4	163·1
32	25·6	19·3	92	73·5	55·4	152	121·4	91·5	212	169·3	127·6	272	217·2	163·7
33	26·4	19·9	93	74·3	56·0	153	122·2	92·1	213	170·1	128·2	273	218·0	164·3
34	27·2	20·5	94	75·1	56·6	154	123·0	92·7	214	170·9	128·8	274	218·8	164·9
35	28·0	21·1	95	75·9	57·2	155	123·8	93·3	215	171·7	129·4	275	219·6	165·5
36	28·8	21·7	96	76·7	57·8	156	124·6	93·9	216	172·5	130·0	276	220·4	166·1
37	29·5	22·3	97	77·5	58·4	157	125·4	94·5	217	173·3	130·6	277	221·2	166·7
38	30·3	22·9	98	78·3	59·0	158	126·2	95·1	218	174·1	131·2	278	222·0	167·3
39	31·1	23·5	99	79·1	59·6	159	127·0	95·7	219	174·9	131·8	279	222·8	167·9
40	31·9	24·1	100	79·9	60·2	160	127·8	96·3	220	175·7	132·4	280	223·6	168·5
41	32·7	24·7	101	80·7	60·8	161	128·6	96·9	221	176·5	133·0	281	224·4	169·1
42	33·5	25·3	102	81·5	61·4	162	129·4	97·5	222	177·3	133·6	282	225·2	169·7
43	34·3	25·9	103	82·3	62·0	163	130·2	98·1	223	178·1	134·2	283	226·0	170·3
44	35·1	26·5	104	83·1	62·6	164	131·0	98·7	224	178·9	134·8	284	226·8	170·9
45	35·9	27·1	105	83·9	63·2	165	131·8	99·3	225	179·7	135·4	285	227·6	171·5
46	36·7	27·7	106	84·7	63·8	166	132·6	99·9	226	180·5	136·0	286	228·4	172·1
47	37·5	28·3	107	85·5	64·4	167	133·4	100·5	227	181·3	136·6	287	229·2	172·7
48	38·3	28·9	108	86·3	65·0	168	134·2	101·1	228	182·1	137·2	288	230·0	173·3
49	39·1	29·5	109	87·1	65·6	169	135·0	101·7	229	182·9	137·8	289	230·8	173·9
50	39·9	30·1	110	87·8	66·2	170	135·8	102·3	230	183·7	138·4	290	231·6	174·5
51	40·7	30·7	111	88·6	66·8	171	136·6	102·9	231	184·5	139·0	291	232·4	175·1
52	41·5	31·3	112	89·4	67·4	172	137·4	103·5	232	185·3	139·6	292	233·2	175·7
53	42·3	31·9	113	90·2	68·0	173	138·2	104·1	233	186·1	140·2	293	234·0	176·3
54	43·1	32·5	114	91·0	68·6	174	139·0	104·7	234	186·9	140·8	294	234·8	176·9
55	43·9	33·1	115	91·8	69·2	175	139·8	105·3	235	187·7	141·4	295	235·6	177·5
56	44·7	33·7	116	92·6	69·8	176	140·6	105·9	236	188·5	142·0	296	236·4	178·1
57	45·5	34·3	117	93·4	70·4	177	141·4	106·5	237	189·3	142·6	297	237·2	178·7
58	46·3	34·9	118	94·2	71·0	178	142·2	107·1	238	190·1	143·2	298	238·0	179·3
59	47·1	35·5	119	95·0	71·6	179	143·0	107·7	239	190·9	143·8	299	238·8	179·9
60	47·9	36·1	120	95·8	72·2	180	143·8	108·3	240	191·7	144·4	300	239·6	180·5
Dist.	Dep.	D.Lat	Dist.	Dep.	D.Lat	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat.
53°														3h 32m

TRAVERSE TABLE TO DEGREES

37° — $2^h\ 28^m$

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	240·4	181·1	361	288·3	217·3	421	336·2	253·4	481	384·1	289·5	541	432·0	325·6
302	241·2	181·7	362	289·1	217·9	422	337·0	254·0	482	384·9	290·0	542	432·8	326·2
303	242·0	182·4	363	289·9	218·5	423	337·8	254·6	483	385·7	290·6	543	433·6	326·8
304	242·7	183·0	364	290·7	219·1	424	338·6	255·2	484	386·5	291·2	544	434·4	327·3
305	243·5	183·6	365	291·5	219·7	425	339·4	255·8	485	387·3	291·8	545	435·2	327·9
306	244·3	184·2	366	292·3	220·3	426	340·2	256·4	486	388·1	292·4	546	436·0	328·5
307	245·1	184·8	367	293·1	220·9	427	341·0	257·0	487	388·9	293·0	547	436·8	329·1
308	245·9	185·4	368	293·9	221·5	428	341·8	257·6	488	389·7	293·6	548	437·6	329·7
309	246·7	186·0	369	294·7	222·1	429	342·6	258·2	489	390·5	294·2	549	438·4	330·3
310	247·5	186·6	370	295·5	222·7	430	343·4	258·8	490	391·3	294·8	550	439·2	330·9
311	248·3	187·2	371	296·3	223·3	431	344·2	259·4	491	392·1	295·4	551	440·0	331·5
312	249·1	187·8	372	297·1	223·9	432	345·0	260·0	492	392·9	296·0	552	440·8	332·1
313	249·9	188·4	373	297·9	224·5	433	345·8	260·6	493	393·7	296·6	553	441·6	332·7
314	250·7	189·0	374	298·7	225·1	434	346·6	261·2	494	394·5	297·2	554	442·4	333·3
315	251·5	189·6	375	299·5	225·7	435	347·4	261·8	495	395·3	297·8	555	443·2	333·9
316	252·3	190·2	376	300·3	226·3	436	348·2	262·4	496	396·1	298·5	556	444·0	334·6
317	253·1	190·8	377	301·1	226·9	437	349·0	263·0	497	396·9	299·1	557	444·8	335·2
318	253·9	191·4	378	301·8	227·5	438	349·8	263·6	498	397·7	299·7	558	445·6	335·8
319	254·7	192·0	379	302·6	228·1	439	350·6	264·2	499	398·5	300·3	559	446·4	336·4
320	255·5	192·6	380	303·4	228·7	440	351·4	264·8	500	399·3	300·9	560	447·2	337·0
321	256·3	193·2	381	304·2	229·3	441	352·2	265·4	501	400·1	301·5	561	448·0	337·6
322	257·1	193·8	382	305·0	229·9	442	353·0	266·0	502	400·9	302·1	562	448·8	338·2
323	257·9	194·4	383	305·8	230·5	443	353·8	266·6	503	401·7	302·7	563	449·6	338·8
324	258·7	195·0	384	306·6	231·1	444	354·6	267·2	504	402·5	303·3	564	450·4	339·4
325	259·5	195·6	385	307·4	231·7	445	355·4	267·8	505	403·3	303·9	565	451·2	340·0
326	260·3	196·2	386	308·2	232·3	446	356·2	268·4	506	404·1	304·5	566	452·0	340·6
327	261·1	196·8	387	309·0	232·9	447	357·0	269·0	507	404·9	305·1	567	452·8	341·2
328	261·9	197·4	388	309·8	233·5	448	357·8	269·6	508	405·7	305·7	568	453·6	341·8
329	262·7	198·0	389	310·6	234·1	449	358·6	270·2	509	406·5	306·3	569	454·4	342·4
330	263·5	198·6	390	311·4	234·7	450	359·4	270·8	510	407·3	306·9	570	455·2	343·0
331	264·3	199·2	391	312·2	235·3	451	360·1	271·4	511	408·1	307·5	571	456·0	343·6
332	265·1	199·8	392	313·0	235·9	452	360·9	272·0	512	408·9	308·2	572	456·8	344·3
333	265·9	200·4	393	313·8	236·5	453	361·7	272·6	513	409·7	308·8	573	457·6	344·9
334	266·7	201·0	394	314·6	237·1	454	362·5	273·2	514	410·5	309·4	574	458·4	345·5
335	267·5	201·6	395	315·4	237·7	455	363·3	273·8	515	411·3	310·0	575	459·2	346·1
336	268·3	202·2	396	316·2	238·3	456	364·1	274·4	516	412·1	310·6	576	460·0	346·7
337	269·1	202·8	397	317·0	238·9	457	364·9	275·0	517	412·9	311·2	577	460·8	347·3
338	269·9	203·4	398	317·8	239·5	458	365·7	275·6	518	413·7	311·8	578	461·6	347·9
339	270·7	204·0	399	318·6	240·1	459	366·5	276·2	519	414·5	312·4	579	462·4	348·5
340	271·5	204·6	400	319·4	240·7	460	367·3	276·8	520	415·3	313·0	580	463·2	349·1
341	272·3	205·2	401	320·2	241·3	461	368·1	277·4	521	416·1	313·6	581	464·0	349·7
342	273·1	205·8	402	321·0	241·9	462	368·9	278·0	522	416·9	314·2	582	464·8	350·3
343	273·9	206·4	403	321·8	242·5	463	369·7	278·6	523	417·7	314·8	583	465·6	350·9
344	274·7	207·0	404	322·6	243·1	464	370·5	279·2	524	418·5	315·4	584	466·4	351·5
345	275·5	207·6	405	323·4	243·7	465	371·3	279·8	525	419·3	316·0	585	467·2	352·1
346	276·3	208·2	406	324·2	244·3	466	372·1	280·4	526	420·1	316·6	586	468·0	352·7
347	277·1	208·8	407	325·0	244·9	467	372·9	281·0	527	420·9	317·2	587	468·8	353·3
348	277·9	209·4	408	325·8	245·5	468	373·7	281·6	528	421·7	317·8	588	469·6	353·9
349	278·7	210·0	409	326·6	246·1	469	374·5	282·3	529	422·5	318·4	589	470·4	354·5
350	279·5	210·6	410	327·4	246·7	470	375·3	282·9	530	423·3	319·0	590	471·2	355·1
351	280·3	211·2	411	328·2	247·3	471	376·1	283·5	531	424·1	319·6	591	472·0	355·7
352	281·1	211·8	412	329·0	247·9	472	376·9	284·1	532	424·9	320·2	592	472·8	356·3
353	281·9	212·4	413	329·8	248·5	473	377·7	284·7	533	425·7	320·8	593	473·6	356·9
354	282·7	213·0	414	330·6	249·2	474	378·5	285·3	534	426·5	321·4	594	474·4	357·5
355	283·5	213·6	415	331·4	249·8	475	379·3	285·9	535	427·3	322·0	595	475·2	358·1
356	284·3	214·2	416	332·2	250·4	476	380·1	286·5	536	428·1	322·6	596	476·0	358·7
357	285·1	214·8	417	333·0	251·0	477	380·9	287·1	537	428·9	323·2	597	476·8	359·3
358	285·9	215·4	418	333·8	251·6	478	381·7	287·7	538	429·7	323·8	598	477·6	359·9
359	286·7	216·1	419	334·6	252·2	479	382·5	288·3	539	430·5	324·4	599	478·4	360·5
360	287·5	216·7	420	335·4	252·8	480	383·3	288·9	540	431·3	325·0	600	479·2	361·1
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

53° — $3^h\ 32^m$

TRAVERSE TABLE TO DEGREES

38° 2h 32m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·8	0·6	61	48·1	37·6	121	95·3	74·5	181	142·6	111·4	241	189·9	148·4
2	1·6	1·2	62	48·9	38·2	122	96·1	75·1	182	143·4	112·1	242	190·7	149·0
3	2·4	1·8	63	49·6	38·8	123	96·9	75·7	183	144·2	112·7	243	191·5	149·6
4	3·2	2·5	64	50·4	39·4	124	97·7	76·3	184	145·0	113·3	244	192·3	150·2
5	3·9	3·1	65	51·2	40·0	125	98·5	77·0	185	145·8	113·9	245	193·1	150·8
6	4·7	3·7	66	52·0	40·6	126	99·3	77·6	186	146·6	114·5	246	193·9	151·5
7	5·5	4·3	67	52·8	41·2	127	100·1	78·2	187	147·4	115·1	247	194·6	152·1
8	6·3	4·9	68	53·6	41·9	128	100·9	78·8	188	148·1	115·7	248	195·4	152·7
9	7·1	5·5	69	54·4	42·5	129	101·7	79·4	189	148·9	116·4	249	196·2	153·3
10	7·9	6·2	70	55·2	43·1	130	102·4	80·0	190	149·7	117·0	250	197·0	153·9
11	8·7	6·8	71	55·9	43·7	131	103·2	80·7	191	150·5	117·6	251	197·8	154·5
12	9·5	7·4	72	56·7	44·3	132	104·0	81·3	192	151·3	118·2	252	198·6	155·1
13	10·2	8·0	73	57·5	44·9	133	104·8	81·9	193	152·1	118·8	253	199·4	155·8
14	11·0	8·6	74	58·3	45·6	134	105·6	82·5	194	152·9	119·4	254	200·2	156·4
15	11·8	9·2	75	59·1	46·2	135	106·4	83·1	195	153·7	120·1	255	200·9	157·0
16	12·6	9·9	76	59·9	46·8	136	107·2	83·7	196	154·5	120·7	256	201·7	157·6
17	13·4	10·5	77	60·7	47·4	137	108·0	84·3	197	155·2	121·3	257	202·5	158·2
18	14·2	11·1	78	61·5	48·0	138	108·7	85·0	198	156·0	121·9	258	203·3	158·8
19	15·0	11·7	79	62·3	48·6	139	109·5	85·6	199	156·8	122·5	259	204·1	159·5
20	15·8	12·3	80	63·0	49·3	140	110·3	86·2	200	157·6	123·1	260	204·9	160·1
21	16·5	12·9	81	63·8	49·9	141	111·1	86·8	201	158·4	123·7	261	205·7	160·7
22	17·3	13·5	82	64·6	50·5	142	111·9	87·4	202	159·2	124·4	262	206·5	161·3
23	18·1	14·2	83	65·4	51·1	143	112·7	88·0	203	160·0	125·0	263	207·2	161·9
24	18·9	14·8	84	66·2	51·7	144	113·5	88·7	204	160·8	125·6	264	208·0	162·5
25	19·7	15·4	85	67·0	52·3	145	114·3	89·3	205	161·5	126·2	265	208·8	163·2
26	20·5	16·0	86	67·8	52·9	146	115·0	89·9	206	162·3	126·8	266	209·6	163·8
27	21·3	16·6	87	68·6	53·6	147	115·8	90·5	207	163·1	127·4	267	210·4	164·4
28	22·1	17·2	88	69·3	54·2	148	116·6	91·1	208	163·9	128·1	268	211·2	165·0
29	22·9	17·9	89	70·1	54·8	149	117·4	91·7	209	164·7	128·7	269	212·0	165·6
30	23·6	18·5	90	70·9	55·4	150	118·2	92·3	210	165·5	129·3	270	212·8	166·2
31	24·4	19·1	91	71·7	56·0	151	119·0	93·0	211	166·3	129·9	271	213·6	166·8
32	25·2	19·7	92	72·5	56·6	152	119·8	93·6	212	167·1	130·5	272	214·3	167·5
33	26·0	20·3	93	73·3	57·3	153	120·6	94·2	213	167·8	131·1	273	215·1	168·1
34	26·8	20·9	94	74·1	57·9	154	121·4	94·8	214	168·6	131·8	274	215·9	168·7
35	27·6	21·5	95	74·9	58·5	155	122·1	95·4	215	169·4	132·4	275	216·7	169·3
36	28·4	22·2	96	75·6	59·1	156	122·9	96·0	216	170·2	133·0	276	217·5	169·9
37	29·2	22·8	97	76·4	59·7	157	123·7	96·7	217	171·0	133·6	277	218·3	170·5
38	29·9	23·4	98	77·2	60·3	158	124·5	97·3	218	171·8	134·2	278	219·1	171·2
39	30·7	24·0	99	78·0	61·0	159	125·3	97·9	219	172·6	134·8	279	219·9	171·8
40	31·5	24·6	100	78·8	61·6	160	126·1	98·5	220	173·4	135·4	280	220·6	172·4
41	32·3	25·2	101	79·6	62·2	161	126·9	99·1	221	174·2	136·1	281	221·4	173·0
42	33·1	25·9	102	80·4	62·8	162	127·7	99·7	222	174·9	136·7	282	222·2	173·6
43	33·9	26·5	103	81·2	63·4	163	128·4	100·4	223	175·7	137·3	283	223·0	174·2
44	34·7	27·1	104	82·0	64·0	164	129·2	101·0	224	176·5	137·9	284	223·8	174·8
45	35·5	27·7	105	82·7	64·6	165	130·0	101·6	225	177·3	138·5	285	224·6	175·5
46	36·2	28·3	106	83·5	65·3	166	130·8	102·2	226	178·1	139·1	286	225·4	176·1
47	37·0	28·9	107	84·3	65·9	167	131·6	102·8	227	178·9	139·8	287	226·2	176·7
48	37·8	29·6	108	85·1	66·5	168	132·4	103·4	228	179·7	140·4	288	226·9	177·3
49	38·6	30·2	109	85·9	67·1	169	133·2	104·0	229	180·5	141·0	289	227·7	177·9
50	39·4	30·8	110	86·7	67·7	170	134·0	104·7	230	181·2	141·6	290	228·5	178·5
51	40·2	31·4	111	87·5	68·3	171	134·7	105·3	231	182·0	142·2	291	229·3	179·2
52	41·0	32·0	112	88·3	69·0	172	135·5	105·9	232	182·8	142·8	292	230·1	179·8
53	41·8	32·6	113	89·0	69·6	173	136·3	106·5	233	183·6	143·4	293	230·9	180·4
54	42·6	33·2	114	89·8	70·2	174	137·1	107·1	234	184·4	144·1	294	231·7	181·0
55	43·3	33·9	115	90·6	70·8	175	137·9	107·7	235	185·2	144·7	295	232·5	181·6
56	44·1	34·5	116	91·4	71·4	176	138·7	108·4	236	186·0	145·3	296	233·3	182·2
57	44·9	35·1	117	92·2	72·0	177	139·5	109·0	237	186·8	145·9	297	234·0	182·9
58	45·7	35·7	118	93·0	72·6	178	140·3	109·6	238	187·5	146·5	298	234·8	183·5
59	46·5	36·3	119	93·8	73·3	179	141·1	110·2	239	188·3	147·1	299	235·6	184·1
60	47·3	36·9	120	94·6	73·9	180	141·8	110·8	240	189·1	147·8	300	236·4	184·7
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

52° 3h 28m

TRAVERSE TABLE TO DEGREES

38° 2h 32m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	237·2	185·3	361	284·5	222·3	421	331·8	259·2	481	379·0	296·2	541	426·3	333·1
302	238·0	185·9	362	285·3	222·9	422	332·5	259·8	482	379·8	296·8	542	427·1	333·7
303	238·8	186·6	363	286·0	223·5	423	333·3	260·4	483	380·6	297·4	543	427·9	334·3
304	239·6	187·2	364	286·8	224·1	424	334·1	261·0	484	381·4	298·0	544	428·7	335·0
305	240·3	187·8	365	287·6	224·7	425	334·9	261·7	485	382·2	298·6	545	429·5	335·6
306	241·1	188·4	366	288·4	225·3	426	335·7	262·3	486	383·0	299·2	546	430·3	336·2
307	241·9	189·0	367	289·2	226·0	427	336·5	262·9	487	383·8	299·8	547	431·0	336·8
308	242·7	189·6	368	290·0	226·6	428	337·3	263·5	488	384·5	300·4	548	431·8	337·4
309	243·5	190·2	369	290·8	227·2	429	338·1	264·1	489	385·3	301·1	549	432·6	338·0
310	244·3	190·9	370	291·6	227·8	430	338·8	264·7	490	386·1	301·7	550	433·4	338·6
311	245·1	191·5	371	292·4	228·4	431	339·6	265·4	491	386·9	302·3	551	434·2	339·3
312	245·9	192·1	372	293·1	229·0	432	340·4	266·0	492	387·7	302·9	552	435·0	339·9
313	246·6	192·7	373	293·9	229·6	433	341·2	266·6	493	388·5	303·5	553	435·8	340·5
314	247·4	193·3	374	294·7	230·3	434	342·0	267·2	494	389·3	304·2	554	436·6	341·1
315	248·2	193·9	375	295·5	230·9	435	342·8	267·8	495	390·1	304·8	555	437·4	341·7
316	249·0	194·6	376	296·3	231·5	436	343·6	268·4	496	390·9	305·4	556	438·1	342·3
317	249·8	195·2	377	297·1	232·1	437	344·4	269·1	497	391·6	306·0	557	438·9	343·0
318	250·6	195·8	378	297·9	232·7	438	345·2	269·7	498	392·4	306·6	558	439·7	343·6
319	251·4	196·4	379	298·7	233·3	439	345·9	270·3	499	393·2	307·2	559	440·5	344·2
320	252·2	197·0	380	299·4	234·0	440	346·7	270·9	500	394·0	307·8	560	441·3	344·8
321	253·0	197·6	381	300·2	234·6	441	347·5	271·5	501	394·8	308·4	561	442·1	345·4
322	253·7	198·2	382	301·0	235·2	442	348·3	272·1	502	395·6	309·1	562	442·9	346·0
323	254·5	198·9	383	301·8	235·8	443	349·1	272·7	503	396·4	309·7	563	443·7	346·6
324	255·3	199·5	384	302·6	236·4	444	349·9	273·4	504	397·2	310·3	564	444·4	347·2
325	256·1	200·1	385	303·4	237·0	445	350·7	274·0	505	397·9	310·9	565	445·2	347·8
326	256·9	200·7	386	304·2	237·7	446	351·5	274·6	506	398·7	311·6	566	446·0	348·5
327	257·7	201·3	387	305·0	238·3	447	352·2	275·2	507	399·5	312·2	567	446·8	349·1
328	258·5	201·9	388	305·7	238·9	448	353·0	275·8	508	400·3	312·8	568	447·6	349·7
329	259·3	202·6	389	306·5	239·5	449	353·8	276·4	509	401·1	313·4	569	448·4	350·3
330	260·0	203·2	390	307·3	240·1	450	354·6	277·1	510	401·9	314·0	570	449·2	350·9
331	260·8	203·8	391	308·1	240·7	451	355·4	277·7	511	402·7	314·6	571	450·0	351·6
332	261·6	204·4	392	308·9	241·3	452	356·2	278·3	512	403·5	315·2	572	450·7	352·2
333	262·4	205·0	393	309·7	242·0	453	357·0	278·9	513	404·2	315·8	573	451·5	352·8
334	263·2	205·6	394	310·5	242·6	454	357·8	279·5	514	405·0	316·4	574	452·3	353·4
335	264·0	206·3	395	311·3	243·2	455	358·5	280·1	515	405·8	317·1	575	453·1	354·0
336	264·8	206·9	396	312·1	243·8	456	359·3	280·7	516	406·6	317·7	576	453·9	354·6
337	265·6	207·5	397	312·8	244·4	457	360·1	281·4	517	407·4	318·3	577	454·7	355·2
338	266·3	208·1	398	313·6	245·0	458	360·9	282·0	518	408·2	318·9	578	455·5	355·8
339	267·1	208·7	399	314·4	245·7	459	361·7	282·6	519	409·0	319·5	579	456·3	356·4
340	267·9	209·3	400	315·2	246·3	460	362·5	283·2	520	409·8	320·2	580	457·1	357·1
341	268·7	209·9	401	316·0	246·9	461	363·3	283·8	521	410·6	320·8	581	457·8	357·7
342	269·5	210·6	402	316·8	247·5	462	364·1	284·4	522	411·3	321·4	582	458·6	358·3
343	270·3	211·2	403	317·6	248·1	463	364·9	285·1	523	412·1	322·0	583	459·4	358·9
344	271·1	211·8	404	318·4	248·7	464	365·6	285·7	524	412·9	322·6	584	460·2	359·5
345	271·9	212·4	405	319·1	249·3	465	366·4	286·3	525	413·7	323·2	585	461·0	360·2
346	272·7	213·0	406	319·9	250·0	466	367·2	286·9	526	414·5	323·8	586	461·8	360·8
347	273·4	213·6	407	320·7	250·6	467	368·0	287·5	527	415·3	324·5	587	462·6	361·4
348	274·2	214·3	408	321·5	251·2	468	368·8	288·1	528	416·1	325·1	588	463·3	362·0
349	275·0	214·9	409	322·3	251·8	469	369·6	288·7	529	416·9	325·7	589	464·1	362·6
350	275·8	215·5	410	323·1	252·4	470	370·4	289·3	530	417·6	326·3	590	464·9	363·2
351	276·6	216·1	411	323·9	253·0	471	371·2	290·0	531	418·4	326·9	591	465·7	363·8
352	277·4	216·7	412	324·7	253·7	472	371·9	290·6	532	419·2	327·5	592	466·5	364·4
353	278·2	217·3	413	325·5	254·3	473	372·7	291·2	533	420·0	328·2	593	467·3	365·1
354	279·0	218·0	414	326·2	254·9	474	373·5	291·8	534	420·8	328·8	594	468·1	365·7
355	279·7	218·6	415	327·0	255·5	475	374·3	292·4	535	421·6	329·4	595	468·9	366·3
356	280·5	219·2	416	327·8	256·1	476	375·1	293·1	536	422·4	330·0	596	469·7	366·9
357	281·3	219·8	417	328·6	256·7	477	375·9	293·7	537	423·2	330·6	597	470·5	367·5
358	282·1	220·4	418	329·4	257·4	478	376·7	294·3	538	424·0	331·2	598	471·2	368·1
359	282·9	221·0	419	330·2	258·0	479	377·5	294·9	539	424·7	331·8	599	472·0	368·7
360	283·7	221·6	420	331·0	258·6	480	378·2	295·5	540	425·5	332·5	600	472·8	369·4
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

52° 3h 28m

TRAVERSE TABLE TO DEGREES

39° — 2h 36m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·8	0·6	61	47·4	38·4	121	94·0	76·1	181	140·7	113·9	241	187·3	151·7
2	1·6	1·3	62	48·2	39·0	122	94·8	76·8	182	141·4	114·5	242	188·1	152·3
3	2·3	1·9	63	49·0	39·6	123	95·6	77·4	183	142·2	115·2	243	188·8	152·9
4	3·1	2·5	64	49·7	40·3	124	96·4	78·0	184	143·0	115·8	244	189·6	153·6
5	3·9	3·1	65	50·5	40·9	125	97·1	78·7	185	143·8	116·4	245	190·4	154·2
6	4·7	3·8	66	51·3	41·5	126	97·9	79·3	186	144·5	117·1	246	191·2	154·8
7	5·4	4·4	67	52·1	42·2	127	98·7	79·9	187	145·3	117·7	247	192·0	155·4
8	6·2	5·0	68	52·8	42·8	128	99·5	80·6	188	146·1	118·3	248	192·7	156·1
9	7·0	5·7	69	53·6	43·4	129	100·3	81·2	189	146·9	118·9	249	193·5	156·7
10	7·8	6·3	70	54·4	44·1	130	101·0	81·8	190	147·7	119·6	250	194·3	157·3
11	8·5	6·9	71	55·2	44·7	131	101·8	82·4	191	148·4	120·2	251	195·1	158·0
12	9·3	7·6	72	56·0	45·3	132	102·6	83·1	192	149·2	120·8	252	195·8	158·6
13	10·1	8·2	73	56·7	45·9	133	103·4	83·7	193	150·0	121·5	253	196·6	159·2
14	10·9	8·8	74	57·5	46·6	134	104·1	84·3	194	150·8	122·1	254	197·4	159·8
15	11·7	9·4	75	58·3	47·2	135	104·9	85·0	195	151·5	122·7	255	198·2	160·5
16	12·4	10·1	76	59·1	47·8	136	105·7	85·6	196	152·3	123·3	256	198·9	161·1
17	13·2	10·7	77	59·8	48·5	137	106·5	86·2	197	153·1	124·0	257	199·7	161·7
18	14·0	11·3	78	60·6	49·1	138	107·2	86·8	198	153·9	124·6	258	200·5	162·4
19	14·8	12·0	79	61·4	49·7	139	108·0	87·5	199	154·7	125·2	259	201·3	163·0
20	15·5	12·6	80	62·2	50·3	140	108·8	88·1	200	155·4	125·9	260	202·1	163·6
21	16·3	13·2	81	62·9	51·0	141	109·6	88·7	201	156·2	126·5	261	202·8	164·3
22	17·1	13·8	82	63·7	51·6	142	110·4	89·4	202	157·0	127·1	262	203·6	164·9
23	17·9	14·5	83	64·5	52·2	143	111·1	90·0	203	157·8	127·8	263	204·4	165·5
24	18·7	15·1	84	65·3	52·9	144	111·9	90·6	204	158·5	128·4	264	205·2	166·1
25	19·4	15·7	85	66·1	53·5	145	112·7	91·3	205	159·3	129·0	265	205·9	166·8
26	20·2	16·4	86	66·8	54·1	146	113·5	91·9	206	160·1	129·6	266	206·7	167·4
27	21·0	17·0	87	67·6	54·8	147	114·2	92·5	207	160·9	130·3	267	207·5	168·0
28	21·8	17·6	88	68·4	55·4	148	115·0	93·1	208	161·6	130·9	268	208·3	168·7
29	22·5	18·3	89	69·2	56·0	149	115·8	93·8	209	162·4	131·5	269	209·1	169·3
30	23·3	18·9	90	69·9	56·6	150	116·6	94·4	210	163·2	132·2	270	209·8	169·9
31	24·1	19·5	91	70·7	57·3	151	117·3	95·0	211	164·0	132·8	271	210·6	170·5
32	24·9	20·1	92	71·5	57·9	152	118·1	95·7	212	164·8	133·4	272	211·4	171·2
33	25·6	20·8	93	72·3	58·5	153	118·9	96·3	213	165·5	134·0	273	212·2	171·8
34	26·4	21·4	94	73·1	59·2	154	119·7	96·9	214	166·3	134·7	274	212·9	172·4
35	27·2	22·0	95	73·8	59·8	155	120·5	97·5	215	167·1	135·3	275	213·7	173·1
36	28·0	22·7	96	74·6	60·4	156	121·2	98·2	216	167·9	135·9	276	214·5	173·7
37	28·8	23·3	97	75·4	61·0	157	122·0	98·8	217	168·6	136·6	277	215·3	174·3
38	29·5	23·9	98	76·2	61·7	158	122·8	99·4	218	169·4	137·2	278	216·0	175·0
39	30·3	24·5	99	76·9	62·3	159	123·6	100·1	219	170·2	137·8	279	216·8	175·6
40	31·1	25·2	100	77·7	62·9	160	124·3	100·7	220	171·0	138·5	280	217·6	176·2
41	31·9	25·8	101	78·5	63·6	161	125·1	101·3	221	171·7	139·1	281	218·4	176·8
42	32·6	26·4	102	79·3	64·2	162	125·9	101·9	222	172·5	139·7	282	219·2	177·5
43	33·4	27·1	103	80·0	64·8	163	126·7	102·6	223	173·3	140·3	283	219·9	178·1
44	34·2	27·7	104	80·8	65·4	164	127·5	103·2	224	174·1	141·0	284	220·7	178·7
45	35·0	28·3	105	81·6	66·1	165	128·2	103·8	225	174·9	141·6	285	221·5	179·4
46	35·7	28·9	106	82·4	66·7	166	129·0	104·5	226	175·6	142·2	286	222·3	180·0
47	36·5	29·6	107	83·2	67·3	167	129·8	105·1	227	176·4	142·9	287	223·0	180·6
48	37·3	30·2	108	83·9	68·0	168	130·6	105·7	228	177·2	143·5	288	223·8	181·2
49	38·1	30·8	109	84·7	68·6	169	131·3	106·4	229	178·0	144·1	289	224·6	181·9
50	38·9	31·5	110	85·5	69·2	170	132·1	107·0	230	178·7	144·7	290	225·4	182·5
51	39·6	32·1	111	86·3	69·9	171	132·9	107·6	231	179·5	145·4	291	226·1	183·1
52	40·4	32·7	112	87·0	70·5	172	133·7	108·2	232	180·3	146·0	292	226·9	183·8
53	41·2	33·4	113	87·8	71·1	173	134·4	108·9	233	181·1	146·6	293	227·7	184·4
54	42·0	34·0	114	88·6	71·7	174	135·2	109·5	234	181·9	147·3	294	228·5	185·0
55	42·7	34·6	115	89·4	72·4	175	136·0	110·1	235	182·6	147·9	295	229·3	185·6
56	43·5	35·2	116	90·1	73·0	176	136·8	110·8	236	183·4	148·5	296	230·0	186·3
57	44·3	35·9	117	90·9	73·6	177	137·6	111·4	237	184·2	149·1	297	230·8	186·9
58	45·1	36·5	118	91·7	74·3	178	138·3	112·0	238	185·0	149·8	298	231·6	187·5
59	45·9	37·1	119	92·5	74·9	179	139·1	112·6	239	185·7	150·4	299	232·4	188·2
60	46·6	37·8	120	93·3	75·5	180	139·9	113·3	240	186·5	151·0	300	233·1	188·8
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

51° — 3h 24m

TRAVERSE TABLE TO DEGREES

39° 2h 36m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	233·9	189·4	361	280·6	227·1	421	327·2	264·9	481	373·8	302·6	541	420·4	340·4
302	234·7	190·0	362	281·3	227·8	422	328·0	265·5	482	374·6	303·3	542	421·2	341·0
303	235·5	190·6	363	282·1	228·4	423	328·7	266·2	483	375·4	303·9	543	422·0	341·7
304	236·3	191·3	364	282·9	229·0	424	329·5	266·8	484	376·1	304·5	544	422·7	342·3
305	237·0	191·9	365	283·7	229·7	425	330·3	267·4	485	376·9	305·2	545	423·5	342·9
306	237·8	192·5	366	284·4	230·3	426	331·1	268·0	486	377·7	305·8	546	424·3	343·6
307	238·6	193·2	367	285·2	230·9	427	331·9	268·7	487	378·5	306·4	547	425·1	344·2
308	239·4	193·8	368	286·0	231·5	428	332·6	269·3	488	379·3	307·1	548	425·9	344·8
309	240·1	194·4	369	286·8	232·2	429	333·4	269·9	489	380·0	307·7	549	426·6	345·5
310	240·9	195·0	370	287·6	232·8	430	334·2	270·6	490	380·8	308·3	550	427·4	346·1
311	241·7	195·7	371	288·3	233·4	431	335·0	271·2	491	381·6	308·9	551	428·2	346·7
312	242·5	196·3	372	289·1	234·1	432	335·7	271·8	492	382·4	309·6	552	429·0	347·4
313	243·3	197·0	373	289·9	234·7	433	336·5	272·5	493	383·1	310·2	553	429·7	348·0
314	244·0	197·6	374	290·7	235·3	434	337·3	273·1	494	383·9	310·8	554	430·5	348·6
315	244·8	198·2	375	291·4	236·0	435	338·1	273·7	495	384·7	311·5	555	431·3	349·2
316	245·6	198·8	376	292·2	236·6	436	338·8	274·3	496	385·5	312·1	556	432·1	349·9
317	246·4	199·5	377	293·0	237·2	437	339·6	275·0	497	386·2	312·7	557	432·8	350·5
318	247·1	200·1	378	293·8	237·8	438	340·4	275·6	498	387·0	313·3	558	433·6	351·1
319	247·9	200·7	379	294·5	238·5	439	341·2	276·2	499	387·8	314·0	559	434·4	351·7
320	248·7	201·3	380	295·3	239·1	440	342·0	276·9	500	388·6	314·7	560	435·2	352·4
321	249·5	202·0	381	296·1	239·7	441	342·7	277·5	501	389·4	315·3	561	435·9	353·0
322	250·3	202·6	382	296·9	240·4	442	343·5	278·1	502	390·1	315·9	562	436·7	353·6
323	251·0	203·2	383	297·7	241·0	443	344·3	278·7	503	390·9	316·5	563	437·5	354·3
324	251·8	203·9	384	298·4	241·6	444	345·1	279·4	504	391·7	317·1	564	438·3	354·9
325	252·6	204·5	385	299·2	242·2	445	345·8	280·0	505	392·5	317·8	565	439·1	355·5
326	253·4	205·1	386	300·0	242·9	446	346·6	280·6	506	393·2	318·4	566	439·8	356·2
327	254·1	205·7	387	300·8	243·5	447	347·4	281·3	507	394·0	319·0	567	440·6	356·8
328	254·9	206·4	388	301·5	244·1	448	348·2	281·9	508	394·8	319·6	568	441·4	357·4
329	255·7	207·0	389	302·3	244·8	449	349·0	282·5	509	395·6	320·3	569	442·2	358·1
330	256·5	207·6	390	303·1	245·4	450	349·7	283·2	510	396·3	320·9	570	443·0	358·7
331	257·2	208·3	391	303·9	246·0	451	350·5	283·8	511	397·1	321·6	571	443·7	359·3
332	258·0	208·9	392	304·7	246·7	452	351·3	284·4	512	397·9	322·2	572	444·5	359·9
333	258·8	209·5	393	305·4	247·3	453	352·1	285·0	513	398·7	322·8	573	445·3	360·6
334	259·6	210·2	394	306·2	247·9	454	352·8	285·7	514	399·4	323·4	574	446·1	361·2
335	260·4	210·8	395	307·0	248·5	455	353·6	286·3	515	400·2	324·1	575	446·9	361·8
336	261·1	211·4	396	307·8	249·2	456	354·4	286·9	516	401·0	324·7	576	447·6	362·4
337	261·9	212·0	397	308·5	249·8	457	355·2	287·6	517	401·8	325·3	577	448·4	363·1
338	262·7	212·7	398	309·3	250·4	458	355·9	288·2	518	402·5	325·9	578	449·2	363·7
339	263·5	213·3	399	310·1	251·1	459	356·7	288·8	519	403·3	326·6	579	450·0	364·3
340	264·2	213·9	400	310·9	251·7	460	357·5	289·4	520	404·1	327·2	580	450·7	365·0
341	265·0	214·6	401	311·6	252·3	461	358·3	290·1	521	404·9	327·8	581	451·5	365·6
342	265·8	215·2	402	312·4	252·9	462	359·1	290·7	522	405·7	328·5	582	452·3	366·2
343	266·6	215·8	403	313·2	253·6	463	359·8	291·3	523	406·4	329·1	583	453·1	366·9
344	267·3	216·4	404	314·0	254·2	464	360·6	292·0	524	407·2	329·7	584	453·9	367·5
345	268·1	217·1	405	314·8	254·8	465	361·4	292·6	525	408·0	330·4	585	454·6	368·1
346	268·9	217·7	406	315·5	255·5	466	362·2	293·2	526	408·8	331·0	586	455·4	368·8
347	269·7	218·3	407	316·3	256·1	467	362·9	293·8	527	409·5	331·6	587	456·2	369·4
348	270·5	219·0	408	317·1	256·7	468	363·7	294·5	528	410·3	332·3	588	457·0	370·0
349	271·2	219·6	409	317·9	257·3	469	364·5	295·1	529	411·1	332·9	589	457·8	370·6
350	272·0	220·2	410	318·6	258·0	470	365·3	295·7	530	411·9	333·5	590	458·5	371·3
351	272·8	220·8	411	319·4	258·6	471	366·0	296·4	531	412·6	334·1	591	459·3	371·9
352	273·6	221·5	412	320·2	259·2	472	366·8	297·0	532	413·4	334·8	592	460·1	372·5
353	274·3	222·1	413	321·0	259·9	473	367·6	297·6	533	414·2	335·4	593	460·9	373·2
354	275·1	222·7	414	321·8	260·5	474	368·4	298·3	534	415·0	336·1	594	461·6	373·8
355	275·9	223·4	415	322·5	261·1	475	369·2	298·9	535	415·8	336·7	595	462·4	374·4
356	276·7	224·0	416	323·3	261·8	476	369·9	299·5	536	416·5	337·3	596	463·2	375·1
357	277·5	224·6	417	324·1	262·4	477	370·7	300·1	537	417·3	337·9	597	464·0	375·7
358	278·2	225·3	418	324·9	263·0	478	371·5	300·8	538	418·1	338·5	598	464·8	376·3
359	279·0	225·9	419	325·6	263·6	479	372·3	301·4	539	418·9	339·1	599	465·5	376·9
360	279·8	226·5	420	326·4	264·3	480	373·0	302·0	540	419·6	339·8	600	466·3	377·6
Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat

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TRAVERSE TABLE TO DEGREES.

40° — 2h 40m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·8	0·6	61	46·7	39·2	121	92·7	77·8	181	138·7	116·3	241	184·6	154·9
2	1·5	1·3	62	47·5	39·9	122	93·5	78·4	182	139·4	117·0	242	185·4	155·6
3	2·3	1·9	63	48·3	40·5	123	94·2	79·1	183	140·2	117·6	243	186·1	156·2
4	3·1	2·6	64	49·0	41·1	124	95·0	79·7	184	141·0	118·3	244	186·9	156·8
5	3·8	3·2	65	49·8	41·8	125	95·8	80·3	185	141·7	118·9	245	187·7	157·5
6	4·6	3·9	66	50·6	42·4	126	96·5	81·0	186	142·5	119·6	246	188·4	158·1
7	5·4	4·5	67	51·3	43·1	127	97·3	81·6	187	143·3	120·2	247	189·2	158·8
8	6·1	5·1	68	52·1	43·7	128	98·1	82·3	188	144·0	120·8	248	190·0	159·4
9	6·9	5·8	69	52·9	44·4	129	98·8	82·9	189	144·8	121·5	249	190·7	160·1
10	7·7	6·4	70	53·6	45·0	130	99·6	83·6	190	145·5	122·1	250	191·5	160·7
11	8·4	7·1	71	54·4	45·6	131	100·4	84·2	191	146·3	122·8	251	192·3	161·3
12	9·2	7·7	72	55·2	46·3	132	101·1	84·8	192	147·1	123·4	252	193·0	162·0
13	10·0	8·4	73	55·9	46·9	133	101·9	85·5	193	147·8	124·1	253	193·8	162·6
14	10·7	9·0	74	56·7	47·6	134	102·6	86·1	194	148·6	124·7	254	194·6	163·3
15	11·5	9·6	75	57·5	48·2	135	103·4	86·8	195	149·4	125·3	255	195·3	163·9
16	12·3	10·3	76	58·2	48·9	136	104·2	87·4	196	150·1	126·0	256	196·1	164·6
17	13·0	10·9	77	59·0	49·5	137	104·9	88·1	197	150·9	126·6	257	196·9	165·2
18	13·8	11·6	78	59·8	50·1	138	105·7	88·7	198	151·7	127·3	258	197·6	165·8
19	14·6	12·2	79	60·5	50·8	139	106·5	89·3	199	152·4	127·9	259	198·4	166·5
20	15·3	12·9	80	61·3	51·4	140	107·2	90·0	200	153·2	128·6	260	199·2	167·1
21	16·1	13·5	81	62·0	52·1	141	108·0	90·6	201	154·0	129·2	261	199·9	167·8
22	16·9	14·1	82	62·8	52·7	142	108·8	91·3	202	154·7	129·8	262	200·7	168·4
23	17·6	14·8	83	63·6	53·4	143	109·5	91·9	203	155·5	130·5	263	201·5	169·1
24	18·4	15·4	84	64·3	54·0	144	110·3	92·6	204	156·3	131·1	264	202·2	169·7
25	19·2	16·1	85	65·1	54·6	145	111·1	93·2	205	157·0	131·8	265	203·0	170·3
26	19·9	16·7	86	65·9	55·3	146	111·8	93·8	206	157·8	132·4	266	203·8	171·0
27	20·7	17·4	87	66·6	55·9	147	112·6	94·5	207	158·6	133·1	267	204·5	171·6
28	21·4	18·0	88	67·4	56·6	148	113·4	95·1	208	159·3	133·7	268	205·3	172·3
29	22·2	18·6	89	68·2	57·2	149	114·1	95·8	209	160·1	134·3	269	206·1	172·9
30	23·0	19·3	90	68·9	57·9	150	114·9	96·4	210	160·9	135·0	270	206·8	173·6
31	23·7	19·9	91	69·7	58·5	151	115·7	97·1	211	161·6	135·6	271	207·6	174·2
32	24·5	20·6	92	70·5	59·1	152	116·4	97·7	212	162·4	136·3	272	208·4	174·8
33	25·3	21·2	93	71·2	59·8	153	117·2	98·3	213	163·2	136·9	273	209·1	175·5
34	26·0	21·9	94	72·0	60·4	154	118·0	99·0	214	163·9	137·6	274	209·9	176·1
35	26·8	22·5	95	72·8	61·1	155	118·7	99·6	215	164·7	138·2	275	210·7	176·8
36	27·6	23·1	96	73·5	61·7	156	119·5	100·3	216	165·5	138·8	276	211·4	177·4
37	28·3	23·8	97	74·3	62·4	157	120·3	100·9	217	166·2	139·5	277	212·2	178·1
38	29·1	24·4	98	75·1	63·0	158	121·0	101·6	218	167·0	140·1	278	213·0	178·7
39	29·9	25·1	99	75·8	63·6	159	121·8	102·2	219	167·8	140·8	279	213·7	179·3
40	30·6	25·7	100	76·6	64·3	160	122·6	102·8	220	168·5	141·4	280	214·5	180·0
41	31·4	26·4	101	77·4	64·9	161	123·3	103·5	221	169·3	142·1	281	215·3	180·6
42	32·2	27·0	102	78·1	65·6	162	124·1	104·1	222	170·1	142·7	282	216·0	181·3
43	32·9	27·6	103	78·9	66·2	163	124·9	104·8	223	170·8	143·3	283	216·8	181·9
44	33·7	28·3	104	79·7	66·8	164	125·6	105·4	224	171·6	144·0	284	217·6	182·6
45	34·5	28·9	105	80·4	67·5	165	126·4	106·1	225	172·4	144·6	285	218·3	183·2
46	35·2	29·6	106	81·2	68·1	166	127·2	106·7	226	173·1	145·3	286	219·1	183·8
47	36·0	30·2	107	82·0	68·8	167	127·9	107·3	227	173·9	145·9	287	219·9	184·5
48	36·8	30·9	108	82·7	69·4	168	128·7	108·0	228	174·7	146·6	288	220·6	185·1
49	37·5	31·5	109	83·5	70·1	169	129·5	108·6	229	175·4	147·2	289	221·4	185·8
50	38·3	32·1	110	84·3	70·7	170	130·2	109·3	230	176·2	147·8	290	222·2	186·4
51	39·1	32·8	111	85·0	71·3	171	131·0	109·9	231	177·0	148·5	291	222·9	187·1
52	39·8	33·4	112	85·8	72·0	172	131·8	110·6	232	177·7	149·1	292	223·7	187·7
53	40·6	34·1	113	86·6	72·6	173	132·5	111·2	233	178·5	149·8	293	224·5	188·3
54	41·4	34·7	114	87·3	73·3	174	133·3	111·8	234	179·3	150·4	294	225·2	189·0
55	42·1	35·4	115	88·1	73·9	175	134·1	112·5	235	180·0	151·1	295	226·0	189·6
56	42·9	36·0	116	88·9	74·6	176	134·8	113·1	236	180·8	151·7	296	226·7	190·3
57	43·7	36·6	117	89·6	75·2	177	135·6	113·8	237	181·6	152·3	297	227·5	190·9
58	44·4	37·3	118	90·4	75·8	178	136·4	114·4	238	182·3	153·0	298	228·3	191·6
59	45·2	37·9	119	91·2	76·5	179	137·1	115·1	239	183·1	153·6	299	229·0	192·2
60	46·0	38·6	120	91·9	77·1	180	137·9	115·7	240	183·9	154·3	300	229·8	192·8
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

50° — 3h 20m

TRAVERSE TABLE TO DEGREES

40° — $2^h\ 40^m$

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	230.6	193.5	361	276.5	232.1	421	322.5	270.6	481	368.5	309.2	541	414.4	347.7
302	231.3	194.1	362	277.3	232.7	422	323.3	271.3	482	369.2	309.8	542	415.2	348.4
303	232.1	194.8	363	278.1	233.3	423	324.0	271.9	483	370.0	310.5	543	416.0	349.0
304	232.9	195.4	364	278.8	234.0	424	324.8	272.6	484	370.8	311.1	544	416.7	349.7
305	233.6	196.1	365	279.6	234.6	425	325.6	273.2	485	371.5	311.7	545	417.5	350.3
306	234.4	196.7	366	280.4	235.3	426	326.3	273.8	486	372.3	312.4	546	418.3	351.0
307	235.2	197.3	367	281.1	235.9	427	327.1	274.5	487	373.1	313.0	547	419.0	351.6
308	235.9	198.0	368	281.9	236.6	428	327.9	275.1	488	373.8	313.6	548	419.8	352.2
309	236.7	198.6	369	282.7	237.2	429	328.6	275.8	489	374.6	314.3	549	420.6	352.9
310	237.5	199.3	370	283.4	237.8	430	329.4	276.4	490	375.4	314.9	550	421.3	353.5
311	238.2	199.9	371	284.2	238.5	431	330.2	277.1	491	376.1	315.6	551	422.1	354.2
312	239.0	200.6	372	285.0	239.1	432	330.9	277.7	492	376.9	316.2	552	422.9	354.8
313	239.8	201.2	373	285.7	239.7	433	331.7	278.3	493	377.7	316.9	553	423.6	355.5
314	240.5	201.8	374	286.5	240.4	434	332.5	279.0	494	378.4	317.5	554	424.4	356.1
315	241.3	202.5	375	287.3	241.0	435	333.2	279.6	495	379.2	318.2	555	425.2	356.8
316	242.1	203.1	376	288.0	241.7	436	334.0	280.3	496	380.0	318.8	556	425.9	357.4
317	242.8	203.8	377	288.8	242.3	437	334.8	280.9	497	380.7	319.5	557	426.7	358.0
318	243.6	204.4	378	289.6	243.0	438	335.5	281.6	498	381.5	320.1	558	427.5	358.7
319	244.4	205.1	379	290.3	243.6	439	336.3	282.2	499	382.3	320.8	559	428.2	359.3
320	245.1	205.7	380	291.1	244.3	440	337.1	282.8	500	383.0	321.4	560	429.0	360.0
321	245.9	206.3	381	291.9	244.9	441	337.8	283.5	501	383.8	322.0	561	429.8	360.6
322	246.7	207.0	382	292.6	245.6	442	338.6	284.1	502	384.6	322.7	562	430.5	361.2
323	247.4	207.6	383	293.4	246.2	443	339.4	284.8	503	385.3	323.3	563	431.3	361.9
324	248.2	208.3	384	294.2	246.8	444	340.1	285.4	504	386.1	324.0	564	432.1	362.5
325	249.0	208.9	385	294.9	247.5	445	340.9	286.0	505	386.8	324.6	565	432.8	363.2
326	249.7	209.6	386	295.7	248.1	446	341.7	286.7	506	387.6	325.2	566	433.6	363.8
327	250.5	210.2	387	296.5	248.8	447	342.4	287.3	507	388.4	325.9	567	434.3	364.5
328	251.3	210.8	388	297.2	249.4	448	343.2	288.0	508	389.2	326.5	568	435.1	365.1
329	252.0	211.5	389	298.0	250.1	449	344.0	288.6	509	389.9	327.1	569	435.9	365.8
330	252.8	212.1	390	298.8	250.7	450	344.7	289.3	510	390.7	327.8	570	436.6	366.4
331	253.6	212.8	391	299.5	251.3	451	345.5	289.9	511	391.5	328.4	571	437.4	367.0
332	254.3	213.4	392	300.3	252.0	452	346.3	290.5	512	392.2	329.1	572	438.2	367.7
333	255.1	214.1	393	301.1	252.6	453	347.0	291.2	513	393.0	329.7	573	438.9	368.3
334	255.9	214.7	394	301.8	253.3	454	347.8	291.8	514	393.8	330.4	574	439.7	369.0
335	256.6	215.3	395	302.6	253.9	455	348.6	292.5	515	394.5	331.0	575	440.5	369.6
336	257.4	216.0	396	303.4	254.6	456	349.3	293.1	516	395.3	331.6	576	441.2	370.2
337	258.2	216.6	397	304.1	255.2	457	350.1	293.8	517	396.1	332.3	577	442.0	370.9
338	258.9	217.3	398	304.9	255.8	458	350.8	294.4	518	396.8	332.9	578	442.8	371.5
339	259.7	217.9	399	305.7	256.5	459	351.6	295.0	519	397.6	333.6	579	443.5	372.2
340	260.5	218.6	400	306.4	257.1	460	352.4	295.7	520	398.3	334.2	580	444.3	372.8
341	261.2	219.2	401	307.2	257.8	461	353.1	296.3	521	399.1	334.9	581	445.1	373.5
342	262.0	219.8	402	308.0	258.4	462	353.9	297.0	522	399.9	335.5	582	445.8	374.1
343	262.8	220.5	403	308.7	259.1	463	354.7	297.6	523	400.6	336.1	583	446.6	374.8
344	263.5	221.1	404	309.5	259.7	464	355.4	298.3	524	401.4	336.8	584	447.4	375.4
345	264.3	221.8	405	310.2	260.3	465	356.2	298.9	525	402.2	337.4	585	448.1	376.0
346	265.1	222.4	406	311.0	261.0	466	357.0	299.5	526	402.9	338.1	586	448.9	376.7
347	265.8	223.1	407	311.8	261.6	467	357.7	300.2	527	403.7	338.7	587	449.7	377.3
348	266.6	223.7	408	312.5	262.3	468	358.5	300.8	528	404.5	339.4	588	450.4	378.0
349	267.4	224.3	409	313.3	262.9	469	359.3	301.5	529	405.2	340.0	589	451.2	378.6
350	268.1	225.0	410	314.1	263.6	470	360.0	302.1	530	406.0	340.6	590	452.0	379.2
351	268.9	225.6	411	314.8	264.2	471	360.8	302.8	531	406.8	341.3	591	452.7	379.9
352	269.6	226.3	412	315.6	264.8	472	361.6	303.4	532	407.5	341.9	592	453.5	380.5
353	270.4	226.9	413	316.4	265.5	473	362.3	304.0	533	408.3	342.6	593	454.3	381.2
354	271.2	227.6	414	317.1	266.1	474	363.1	304.7	534	409.1	343.2	594	455.0	381.8
355	271.9	228.2	415	317.9	266.8	475	363.9	305.3	535	409.8	343.9	595	455.8	382.4
356	272.7	228.8	416	318.7	267.4	476	364.6	306.0	536	410.6	344.5	596	456.6	383.1
357	273.5	229.5	417	319.4	268.1	477	365.4	306.6	537	411.4	345.2	597	457.3	383.7
358	274.2	230.1	418	320.2	268.7	478	366.2	307.3	538	412.1	345.8	598	458.1	384.4
359	275.0	230.8	419	321.0	269.3	479	366.9	307.9	539	412.9	346.4	599	458.9	385.0
360	275.8	231.4	420	321.7	270.0	480	367.7	308.5	540	413.7	347.1	600	459.6	385.7
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

50° — $3^h\ 20^m$

TRAVERSE TABLE TO DEGREES

41° 2h 44m

Dist.	D.Lat	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·8	0·7	61	46·0	40·0	121	91·3	79·4	181	136·6	118·7	241	181·9	158·1
2	1·5	1·3	62	46·8	40·7	122	92·1	80·0	182	137·4	119·4	242	182·6	158·8
3	2·3	2·0	63	47·5	41·3	123	92·8	80·7	183	138·1	120·1	243	183·4	159·4
4	3·0	2·6	64	48·3	42·0	124	93·6	81·4	184	138·9	120·7	244	184·1	160·1
5	3·8	3·3	65	49·1	42·6	125	94·3	82·0	185	139·6	121·4	245	184·9	160·7
6	4·5	3·9	66	49·8	43·3	126	95·1	82·7	186	140·4	122·0	246	185·7	161·4
7	5·3	4·6	67	50·6	44·0	127	95·8	83·3	187	141·1	122·7	247	186·4	162·0
8	6·0	5·2	68	51·3	44·6	128	96·6	84·0	188	141·9	123·3	248	187·2	162·7
9	6·8	5·9	69	52·1	45·3	129	97·4	84·6	189	142·6	124·0	249	187·9	163·4
10	7·5	6·6	70	52·8	45·9	130	98·1	85·3	190	143·4	124·7	250	188·7	164·0
11	8·3	7·2	71	53·6	46·6	131	98·9	85·9	191	144·1	125·3	251	189·4	164·7
12	9·1	7·9	72	54·3	47·2	132	99·6	86·6	192	144·9	126·0	252	190·2	165·3
13	9·8	8·5	73	55·1	47·9	133	100·4	87·3	193	145·7	126·6	253	190·9	166·0
14	10·6	9·2	74	55·8	48·5	134	101·1	87·9	194	146·4	127·3	254	191·7	166·6
15	11·3	9·8	75	56·6	49·2	135	101·9	88·6	195	147·2	127·9	255	192·5	167·3
16	12·1	10·5	76	57·4	49·9	136	102·6	89·2	196	147·9	128·6	256	193·2	168·0
17	12·8	11·2	77	58·1	50·5	137	103·4	89·9	197	148·7	129·2	257	194·0	168·6
18	13·6	11·8	78	58·9	51·2	138	104·1	90·5	198	149·4	129·9	258	194·7	169·3
19	14·3	12·5	79	59·6	51·8	139	104·9	91·2	199	150·2	130·6	259	195·5	169·9
20	15·1	13·1	80	60·4	52·5	140	105·7	91·8	200	150·9	131·2	260	196·2	170·6
21	15·8	13·8	81	61·1	53·1	141	106·4	92·5	201	151·7	131·9	261	197·0	171·2
22	16·6	14·4	82	61·9	53·8	142	107·2	93·2	202	152·5	132·5	262	197·7	171·9
23	17·4	15·1	83	62·6	54·5	143	107·9	93·8	203	153·2	133·2	263	198·5	172·5
24	18·1	15·7	84	63·4	55·1	144	108·7	94·5	204	154·0	133·8	264	199·2	173·2
25	18·9	16·4	85	64·2	55·8	145	109·4	95·1	205	154·7	134·5	265	200·0	173·9
26	19·6	17·1	86	64·9	56·4	146	110·2	95·8	206	155·5	135·1	266	200·8	174·5
27	20·4	17·7	87	65·7	57·1	147	110·9	96·4	207	156·2	135·8	267	201·5	175·2
28	21·1	18·4	88	66·4	57·7	148	111·7	97·1	208	157·0	136·5	268	202·3	175·8
29	21·9	19·0	89	67·2	58·4	149	112·5	97·8	209	157·7	137·1	269	203·0	176·5
30	22·6	19·7	90	67·9	59·0	150	113·2	98·4	210	158·5	137·8	270	203·8	177·1
31	23·4	20·3	91	68·7	59·7	151	114·0	99·1	211	159·2	138·4	271	204·5	177·8
32	24·2	21·0	92	69·4	60·4	152	114·7	99·7	212	160·0	139·1	272	205·3	178·4
33	24·9	21·6	93	70·2	61·0	153	115·5	100·4	213	160·8	139·7	273	206·0	179·1
34	25·7	22·3	94	70·9	61·7	154	116·2	101·0	214	161·5	140·4	274	206·8	179·8
35	26·4	23·0	95	71·7	62·3	155	117·0	101·7	215	162·3	141·1	275	207·5	180·4
36	27·2	23·6	96	72·5	63·0	156	117·7	102·3	216	163·0	141·7	276	208·3	181·1
37	27·9	24·3	97	73·2	63·6	157	118·5	103·0	217	163·8	142·4	277	209·1	181·7
38	28·7	24·9	98	74·0	64·3	158	119·2	103·7	218	164·5	143·0	278	209·8	182·4
39	29·4	25·6	99	74·7	64·9	159	120·0	104·3	219	165·3	143·7	279	210·6	183·0
40	30·2	26·2	100	75·5	65·6	160	120·8	105·0	220	166·0	144·3	280	211·3	183·7
41	30·9	26·9	101	76·2	66·3	161	121·5	105·6	221	166·8	145·0	281	212·1	184·4
42	31·7	27·6	102	77·0	66·9	162	122·3	106·3	222	167·5	145·6	282	212·8	185·0
43	32·5	28·2	103	77·7	67·6	163	123·0	106·9	223	168·3	146·3	283	213·6	185·7
44	33·2	28·9	104	78·5	68·2	164	123·8	107·6	224	169·1	147·0	284	214·3	186·3
45	34·0	29·5	105	79·2	68·9	165	124·5	108·2	225	169·8	147·6	285	215·1	187·0
46	34·7	30·2	106	80·0	69·5	166	125·3	108·9	226	170·6	148·3	286	215·8	187·6
47	35·5	30·8	107	80·8	70·2	167	126·0	109·6	227	171·3	148·9	287	216·6	188·3
48	36·2	31·5	108	81·5	70·9	168	126·8	110·2	228	172·1	149·6	288	217·4	188·9
49	37·0	32·1	109	82·3	71·5	169	127·5	110·9	229	172·8	150·2	289	218·1	189·6
50	37·7	32·8	110	83·0	72·2	170	128·3	111·5	230	173·6	150·9	290	218·9	190·3
51	38·5	33·5	111	83·8	72·8	171	129·1	112·2	231	174·3	151·5	291	219·6	190·9
52	39·2	34·1	112	84·5	73·5	172	129·8	112·8	232	175·1	152·2	292	220·4	191·6
53	40·0	34·8	113	85·3	74·1	173	130·6	113·5	233	175·8	152·9	293	221·1	192·2
54	40·8	35·4	114	86·0	74·8	174	131·3	114·2	234	176·6	153·5	294	221·9	192·9
55	41·5	36·1	115	86·8	75·4	175	132·1	114·8	235	177·4	154·2	295	222·6	193·5
56	42·3	36·7	116	87·5	76·1	176	132·8	115·5	236	178·1	154·8	296	223·4	194·2
57	43·0	37·4	117	88·3	76·8	177	133·6	116·1	237	178·9	155·5	297	224·1	194·8
58	43·8	38·1	118	89·1	77·4	178	134·3	116·8	238	179·6	156·1	298	224·9	195·5
59	44·5	38·7	119	89·8	78·1	179	135·1	117·4	239	180·4	156·8	299	225·7	196·2
60	45·3	39·4	120	90·6	78·7	180	135·8	118·1	240	181·1	157·5	300	226·4	196·8
Dist.	Dep.	D.Lat	Dist.	Dep.	D.Lat	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat	Dist.	Dep.	D. Lat.

49° 3h 16m

TRAVERSE TABLE TO DEGREES

41° 2h 44m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	227.2	197.5	361	272.5	236.9	421	317.7	276.2	481	363.0	315.6	541	408.3	354.9
302	227.9	198.1	362	273.2	237.5	422	318.5	276.9	482	363.8	316.2	542	409.0	355.6
303	228.7	198.8	363	274.0	238.2	423	319.2	277.5	483	364.5	316.9	543	409.8	356.2
304	229.4	199.4	364	274.7	238.8	424	320.0	278.2	484	365.3	317.5	544	410.6	356.9
305	230.2	200.1	365	275.5	239.5	425	320.8	278.8	485	366.0	318.2	545	411.3	357.5
306	230.9	200.8	366	276.2	240.1	426	321.5	279.5	486	366.8	318.8	546	412.1	358.2
307	231.7	201.4	367	277.0	240.8	427	322.3	280.1	487	367.5	319.5	547	412.8	358.8
308	232.5	202.1	368	277.7	241.4	428	323.0	280.8	488	368.3	320.1	548	413.6	359.5
309	233.2	202.7	369	278.5	242.1	429	323.8	281.5	489	369.0	320.8	549	414.3	360.2
310	234.0	203.4	370	279.2	242.7	430	324.5	282.1	490	369.8	321.5	550	415.1	360.8
311	234.7	204.0	371	280.0	243.4	431	325.3	282.8	491	370.6	322.1	551	415.8	361.5
312	235.5	204.7	372	280.8	244.1	432	326.0	283.4	492	371.3	322.8	552	416.6	362.1
313	236.2	205.4	373	281.5	244.7	433	326.8	284.1	493	372.1	323.4	553	417.3	362.8
314	237.0	206.0	374	282.3	245.4	434	327.5	284.7	494	372.8	324.1	554	418.1	363.4
315	237.7	206.7	375	283.0	246.0	435	328.3	285.4	495	373.6	324.7	555	418.9	364.1
316	238.5	207.3	376	283.8	246.7	436	329.1	286.0	496	374.3	325.4	556	419.6	364.8
317	239.2	208.0	377	284.5	247.3	437	329.8	286.7	497	375.1	326.0	557	420.4	365.4
318	240.0	208.6	378	285.3	248.0	438	330.6	287.4	498	375.8	326.7	558	421.1	366.1
319	240.8	209.3	379	286.0	248.7	439	331.3	288.0	499	376.6	327.4	559	421.9	366.7
320	241.5	209.9	380	286.8	249.3	440	332.1	288.7	500	377.3	328.0	560	422.6	367.4
321	242.3	210.6	381	287.5	250.0	441	332.8	289.3	501	378.1	328.7	561	423.4	368.0
322	243.0	211.3	382	288.3	250.6	442	333.6	290.0	502	378.9	329.3	562	424.1	368.7
323	243.8	211.9	383	289.1	251.3	443	334.3	290.6	503	379.6	330.0	563	424.9	369.4
324	244.5	212.6	384	289.8	251.9	444	335.1	291.3	504	380.4	330.6	564	425.7	370.0
325	245.3	213.2	385	290.6	252.6	445	335.8	292.0	505	381.1	331.3	565	426.4	370.7
326	246.0	213.9	386	291.3	253.2	446	336.6	292.6	506	381.9	332.0	566	427.2	371.3
327	246.8	214.5	387	292.1	253.9	447	337.4	293.3	507	382.6	332.6	567	427.9	372.0
328	247.5	215.2	388	292.8	254.6	448	338.1	293.9	508	383.4	333.3	568	428.7	372.6
329	248.3	215.9	389	293.6	255.2	449	338.9	294.6	509	384.1	333.9	569	429.4	373.3
330	249.1	216.5	390	294.3	255.9	450	339.6	295.2	510	384.9	334.6	570	430.2	374.0
331	249.8	217.2	391	295.1	256.5	451	340.4	295.9	511	385.7	335.2	571	430.9	374.6
332	250.6	217.8	392	295.8	257.2	452	341.1	296.5	512	386.4	335.9	572	431.7	375.3
333	251.3	218.5	393	296.6	257.8	453	341.9	297.2	513	387.2	336.5	573	432.4	375.9
334	252.1	219.1	394	297.4	258.5	454	342.6	297.9	514	387.9	337.2	574	433.2	376.6
335	252.8	219.8	395	298.1	259.2	455	343.4	298.5	515	388.7	337.9	575	434.0	377.2
336	253.6	220.4	396	298.9	259.8	456	344.1	299.2	516	389.4	338.5	576	434.7	377.9
337	254.3	221.1	397	299.6	260.5	457	344.9	299.8	517	390.2	339.2	577	435.5	378.5
338	255.1	221.8	398	300.4	261.1	458	345.7	300.5	518	390.9	339.8	578	436.2	379.2
339	255.8	222.4	399	301.1	261.8	459	346.4	301.1	519	391.7	340.5	579	437.0	379.8
340	256.6	223.1	400	301.9	262.4	460	347.2	301.8	520	392.4	341.1	580	437.7	380.5
341	257.4	223.7	401	302.6	263.1	461	347.9	302.5	521	393.2	341.8	581	438.5	381.2
342	258.1	224.4	402	303.4	263.7	462	348.7	303.1	522	394.0	342.5	582	439.2	381.8
343	258.9	225.0	403	304.2	264.4	463	349.4	303.8	523	394.7	343.1	583	440.0	382.5
344	259.6	225.7	404	304.9	265.1	464	350.2	304.4	524	395.5	343.8	584	440.7	383.2
345	260.4	226.3	405	305.7	265.7	465	350.9	305.1	525	396.2	344.4	585	441.5	383.8
346	261.1	227.0	406	306.4	266.4	466	351.7	305.7	526	397.0	345.1	586	442.3	384.5
347	261.9	227.7	407	307.2	267.0	467	352.5	306.4	527	397.7	345.7	587	443.0	385.1
348	262.6	228.3	408	307.9	267.7	468	353.2	307.0	528	398.5	346.4	588	443.8	385.8
349	263.4	229.0	409	308.7	268.3	469	354.0	307.7	529	399.2	347.0	589	444.5	386.4
350	264.2	229.6	410	309.4	269.0	470	354.7	308.4	530	400.0	347.7	590	445.3	387.1
351	264.9	230.3	411	310.2	269.6	471	355.5	309.0	531	400.7	348.4	591	446.0	387.7
352	265.7	230.9	412	310.9	270.3	472	356.2	309.7	532	401.5	349.0	592	446.8	388.4
353	266.4	231.6	413	311.7	271.0	473	357.0	310.3	533	402.2	349.7	593	447.5	389.1
354	267.2	232.3	414	312.5	271.6	474	357.7	311.0	534	403.0	350.3	594	448.3	389.7
355	267.9	232.9	415	313.2	272.3	475	358.5	311.6	535	403.8	351.0	595	449.1	390.4
356	268.7	233.6	416	314.0	272.9	476	359.2	312.3	536	404.5	351.6	596	449.8	391.0
357	269.4	234.2	417	314.7	273.6	477	360.0	312.9	537	405.3	352.3	597	450.6	391.7
358	270.2	234.9	418	315.5	274.2	478	360.8	313.6	538	406.0	352.9	598	451.3	392.3
359	270.9	235.5	419	316.2	274.9	479	361.5	314.3	539	406.8	353.6	599	452.1	393.0
360	271.7	236.2	420	317.0	275.6	480	362.3	314.9	540	407.5	354.3	600	452.8	393.6
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

49° 3h 16m

TRAVERSE TABLE TO DEGREES

42° — $2^h\ 48^m$

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·7	0·7	61	45·3	40·8	121	89·9	81·0	181	134·5	121·1	241	179·1	161·3
2	1·5	1·3	62	46·1	41·5	122	90·7	81·6	182	135·3	121·8	242	179·8	161·9
3	2·2	2·0	63	46·8	42·2	123	91·4	82·3	183	136·0	122·5	243	180·6	162·6
4	3·0	2·7	64	47·6	42·8	124	92·1	83·0	184	136·7	123·1	244	181·3	163·3
5	3·7	3·3	65	48·3	43·5	125	92·9	83·6	185	137·5	123·8	245	182·1	163·9
6	4·5	4·0	66	49·0	44·2	126	93·6	84·3	186	138·2	124·5	246	182·8	164·6
7	5·2	4·7	67	49·8	44·8	127	94·4	85·0	187	139·0	125·1	247	183·6	165·3
8	5·9	5·4	68	50·5	45·5	128	95·1	85·6	188	139·7	125·8	248	184·3	165·9
9	6·7	6·0	69	51·3	46·2	129	95·9	86·3	189	140·5	126·5	249	185·0	166·6
10	7·4	6·7	70	52·0	46·8	130	96·6	87·0	190	141·2	127·1	250	185·8	167·3
11	8·2	7·4	71	52·8	47·5	131	97·4	87·7	191	141·9	127·8	251	186·5	168·0
12	8·9	8·0	72	53·5	48·2	132	98·1	88·3	192	142·7	128·5	252	187·3	168·6
13	9·7	8·7	73	54·2	48·8	133	98·8	89·0	193	143·4	129·1	253	188·0	169·3
14	10·4	9·4	74	55·0	49·5	134	99·6	89·7	194	144·2	129·8	254	188·8	170·0
15	11·1	10·0	75	55·7	50·2	135	100·3	90·3	195	144·9	130·5	255	189·5	170·6
16	11·9	10·7	76	56·5	50·9	136	101·1	91·0	196	145·7	131·1	256	190·2	171·3
17	12·6	11·4	77	57·2	51·5	137	101·8	91·7	197	146·4	131·8	257	191·0	172·0
18	13·4	12·0	78	58·0	52·2	138	102·6	92·3	198	147·1	132·5	258	191·7	172·6
19	14·1	12·7	79	58·7	52·9	139	103·3	93·0	199	147·9	133·2	259	192·5	173·3
20	14·9	13·4	80	59·5	53·5	140	104·0	93·7	200	148·6	133·8	260	193·2	174·0
21	15·6	14·1	81	60·2	54·2	141	104·8	94·3	201	149·4	134·5	261	194·0	174·6
22	16·3	14·7	82	60·9	54·9	142	105·5	95·0	202	150·1	135·2	262	194·7	175·3
23	17·1	15·4	83	61·7	55·5	143	106·3	95·7	203	150·9	135·8	263	195·4	176·0
24	17·8	16·1	84	62·4	56·2	144	107·0	96·4	204	151·6	136·5	264	196·2	176·7
25	18·6	16·7	85	63·2	56·9	145	107·8	97·0	205	152·3	137·2	265	196·9	177·3
26	19·3	17·4	86	63·9	57·5	146	108·5	97·7	206	153·1	137·8	266	197·7	178·0
27	20·1	18·1	87	64·7	58·2	147	109·2	98·4	207	153·8	138·5	267	198·4	178·7
28	20·8	18·7	88	65·4	58·9	148	110·0	99·0	208	154·6	139·2	268	199·2	179·3
29	21·6	19·4	89	66·1	59·6	149	110·7	99·7	209	155·3	139·8	269	199·9	180·0
30	22·3	20·1	90	66·9	60·2	150	111·5	100·4	210	156·1	140·5	270	200·6	180·7
31	23·0	20·7	91	67·6	60·9	151	112·2	101·0	211	156·8	141·2	271	201·4	181·3
32	23·8	21·4	92	68·4	61·6	152	113·0	101·7	212	157·5	141·9	272	202·1	182·0
33	24·5	22·1	93	69·1	62·2	153	113·7	102·4	213	158·3	142·5	273	202·9	182·7
34	25·3	22·8	94	69·9	62·9	154	114·4	103·0	214	159·0	143·2	274	203·6	183·3
35	26·0	23·4	95	70·6	63·6	155	115·2	103·7	215	159·8	143·9	275	204·4	184·0
36	26·8	24·1	96	71·3	64·2	156	115·9	104·4	216	160·5	144·5	276	205·1	184·7
37	27·5	24·8	97	72·1	64·9	157	116·7	105·1	217	161·3	145·2	277	205·9	185·3
38	28·2	25·4	98	72·8	65·6	158	117·4	105·7	218	162·0	145·9	278	206·6	186·0
39	29·0	26·1	99	73·6	66·2	159	118·2	106·4	219	162·7	146·5	279	207·3	186·7
40	29·7	26·8	100	74·3	66·9	160	118·9	107·1	220	163·5	147·2	280	208·1	187·4
41	30·5	27·4	101	75·1	67·6	161	119·6	107·7	221	164·2	147·9	281	208·8	188·0
42	31·2	28·1	102	75·8	68·3	162	120·4	108·4	222	165·0	148·5	282	209·6	188·7
43	32·0	28·8	103	76·5	68·9	163	121·1	109·1	223	165·7	149·2	283	210·3	189·4
44	32·7	29·4	104	77·3	69·6	164	121·9	109·7	224	166·5	149·9	284	211·1	190·0
45	33·4	30·1	105	78·0	70·3	165	122·6	110·4	225	167·2	150·6	285	211·8	190·7
46	34·2	30·8	106	78·8	70·9	166	123·4	111·1	226	168·0	151·2	286	212·5	191·4
47	34·9	31·4	107	79·5	71·6	167	124·1	111·7	227	168·7	151·9	287	213·3	192·0
48	35·7	32·1	108	80·3	72·3	168	124·8	112·4	228	169·4	152·6	288	214·0	192·7
49	36·4	32·8	109	81·0	72·9	169	125·6	113·1	229	170·2	153·2	289	214·8	193·4
50	37·2	33·5	110	81·7	73·6	170	126·3	113·8	230	170·9	153·9	290	215·5	194·0
51	37·9	34·1	111	82·5	74·3	171	127·1	114·4	231	171·7	154·6	291	216·3	194·7
52	38·6	34·8	112	83·2	74·9	172	127·8	115·1	232	172·4	155·2	292	217·0	195·4
53	39·4	35·5	113	84·0	75·6	173	128·6	115·8	233	173·2	155·9	293	217·7	196·1
54	40·1	36·1	114	84·7	76·3	174	129·3	116·4	234	173·9	156·6	294	218·5	196·7
55	40·9	36·8	115	85·5	77·0	175	130·1	117·1	235	174·6	157·2	295	219·2	197·4
56	41·6	37·5	116	86·2	77·6	176	130·8	117·8	236	175·4	157·9	296	220·0	198·1
57	42·4	38·1	117	86·9	78·3	177	131·5	118·4	237	176·1	158·6	297	220·7	198·7
58	43·1	38·8	118	87·7	79·0	178	132·3	119·1	238	176·9	159·3	298	221·5	199·4
59	43·8	39·5	119	88·4	79·6	179	133·0	119·8	239	177·6	159·9	299	222·2	200·1
60	44·6	40·1	120	89·2	80·3	180	133·8	120·4	240	178·4	160·6	300	222·9	200·7
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

48° — $3^h\ 12^m$

TRAVERSE TABLE TO DEGREES

42° 2h 48m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	223·7	201·4	361	268·3	241·6	421	312·9	281·7	481	357·5	321·9	541	402·1	362·0
302	224·4	202·1	362	269·0	242·2	422	313·6	282·4	482	358·2	322·5	542	402·8	362·7
303	225·2	202·8	363	269·8	242·9	423	314·4	283·0	483	358·9	323·2	543	403·5	363·3
304	225·9	203·4	364	270·5	243·6	424	315·1	283·7	484	359·7	323·9	544	404·3	364·0
305	226·6	204·1	365	271·2	244·2	425	315·8	284·4	485	360·4	324·6	545	405·0	364·7
306	227·4	204·8	366	272·0	244·9	426	316·6	285·1	486	361·2	325·2	546	405·8	365·4
307	228·1	205·4	367	272·7	245·6	427	317·3	285·7	487	361·9	325·9	547	406·5	366·0
308	228·9	206·1	368	273·5	246·2	428	318·1	286·4	488	362·7	326·6	548	407·2	366·7
309	229·6	206·8	369	274·2	246·9	429	318·8	287·1	489	363·4	327·2	549	408·0	367·4
310	230·4	207·4	370	275·0	247·6	430	319·6	287·7	490	364·1	327·9	550	408·7	368·0
311	231·1	208·1	371	275·7	248·3	431	320·3	288·4	491	364·9	328·6	551	409·5	368·7
312	231·9	208·8	372	276·5	248·9	432	321·0	289·1	492	365·6	329·2	552	410·2	369·4
313	232·6	209·4	373	277·2	249·6	433	321·8	289·7	493	366·4	329·9	553	411·0	370·0
314	233·3	210·1	374	277·9	250·3	434	322·5	290·4	494	367·1	330·6	554	411·7	370·7
315	234·1	210·8	375	278·7	250·9	435	323·3	291·1	495	367·9	331·3	555	412·4	371·4
316	234·8	211·5	376	279·4	251·6	436	324·0	291·7	496	368·6	331·9	556	413·2	372·0
317	235·6	212·1	377	280·2	252·3	437	324·8	292·4	497	369·3	332·5	557	413·9	372·7
318	236·3	212·8	378	280·9	252·9	438	325·5	293·1	498	370·1	333·3	558	414·7	373·4
319	237·1	213·5	379	281·7	253·6	439	326·2	293·8	499	370·8	333·9	559	415·4	374·1
320	237·8	214·1	380	282·4	254·3	440	327·0	294·4	500	371·6	334·6	560	416·2	374·7
321	238·6	214·8	381	283·1	254·9	441	327·7	295·1	501	372·3	335·3	561	416·9	375·4
322	239·3	215·5	382	283·9	255·6	442	328·5	295·8	502	373·1	335·9	562	417·6	376·1
323	240·0	216·1	383	284·6	256·3	443	329·2	296·4	503	373·8	336·6	563	418·4	376·7
324	240·8	216·8	384	285·4	257·0	444	330·0	297·1	504	374·5	337·2	564	419·1	377·4
325	241·5	217·5	385	286·1	257·6	445	330·7	297·8	505	375·3	337·9	565	419·9	378·1
326	242·3	218·1	386	286·9	258·3	446	331·4	298·4	506	376·0	338·6	566	420·6	378·7
327	243·0	218·8	387	287·6	259·0	447	332·2	299·1	507	376·8	339·3	567	421·4	379·4
328	243·8	219·5	388	288·3	259·6	448	332·9	299·8	508	377·5	339·9	568	422·1	380·1
329	244·5	220·1	389	289·1	260·3	449	333·7	300·4	509	378·3	340·6	569	422·8	380·7
330	245·2	220·8	390	289·8	261·0	450	334·4	301·1	510	379·0	341·3	570	423·6	381·4
331	246·0	221·5	391	290·6	261·6	451	335·2	301·8	511	379·7	341·9	571	424·3	382·1
332	246·7	222·2	392	291·3	262·3	452	335·9	302·5	512	380·5	342·6	572	425·1	382·8
333	247·5	222·8	393	292·1	263·0	453	336·6	303·1	513	381·2	343·3	573	425·8	383·4
334	248·2	223·5	394	292·8	263·6	454	337·4	303·8	514	382·0	343·9	574	426·6	384·1
335	249·0	224·2	395	293·5	264·3	455	338·1	304·5	515	382·7	344·6	575	427·3	384·8
336	249·7	224·8	396	294·3	265·0	456	338·9	305·1	516	383·5	345·3	576	428·0	385·4
337	250·4	225·5	397	295·0	265·7	457	339·6	305·8	517	384·2	346·0	577	428·8	386·1
338	251·2	226·2	398	295·8	266·3	458	340·4	306·5	518	384·9	346·6	578	429·5	386·8
339	251·9	226·8	399	296·5	267·0	459	341·1	307·1	519	385·7	347·3	579	430·3	387·4
340	252·7	227·5	400	297·3	267·7	460	341·8	307·8	520	386·4	348·0	580	431·0	388·1
341	253·4	228·2	401	298·0	268·3	461	342·6	308·5	521	387·2	348·6	581	431·8	388·8
342	254·2	228·8	402	298·7	269·0	462	343·3	309·1	522	387·9	349·3	582	432·5	389·4
343	254·9	229·5	403	299·5	269·7	463	344·1	309·8	523	388·7	350·0	583	433·2	390·1
344	255·6	230·2	404	300·2	270·3	464	344·8	310·5	524	389·4	350·6	584	434·0	390·8
345	256·4	230·9	405	301·0	271·0	465	345·6	311·2	525	390·1	351·3	585	434·7	391·4
346	257·1	231·5	406	301·7	271·7	466	346·3	311·8	526	390·9	352·0	586	435·5	392·1
347	257·9	232·2	407	302·5	272·3	467	347·0	312·5	527	391·6	352·6	587	436·2	392·8
348	258·6	232·9	408	303·2	273·0	468	347·8	313·2	528	392·4	353·3	588	437·0	393·4
349	259·4	233·5	409	303·9	273·7	469	348·5	313·8	529	393·1	354·0	589	437·7	394·1
350	260·1	234·2	410	304·7	274·3	470	349·3	314·5	530	393·9	354·6	590	438·4	394·8
351	260·8	234·9	411	305·4	275·0	471	350·0	315·2	531	394·6	355·3	591	439·2	395·4
352	261·6	235·5	412	306·2	275·7	472	350·8	315·8	532	395·3	356·0	592	440·0	396·1
353	262·3	236·2	413	306·9	276·4	473	351·5	316·5	533	396·1	356·6	593	440·7	396·8
354	263·1	236·9	414	307·7	277·0	474	352·3	317·2	534	396·8	357·3	594	441·4	397·5
355	263·8	237·5	415	308·4	277·7	475	353·0	317·8	535	397·6	358·0	595	442·2	398·1
356	264·6	238·2	416	309·1	278·4	476	353·7	318·5	536	398·3	358·6	596	442·9	398·8
357	265·3	238·9	417	309·9	279·0	477	354·5	319·2	537	399·1	359·3	597	443·7	399·5
358	266·0	239·6	418	310·6	279·7	478	355·2	319·9	538	399·8	360·0	598	444·4	400·1
359	266·8	240·2	419	311·4	280·4	479	356·0	320·5	539	400·6	360·6	599	445·2	400·8
360	267·5	240·9	420	312·1	281·0	480	356·7	321·2	540	401·3	361·3	600	445·9	401·5
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

48° 3h 12m

TRAVERSE TABLE TO DEGREES

43° 2h 52m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·7	0·7	61	44·6	41·6	121	88·5	82·5	181	132·4	123·4	241	176·3	164·4
2	1·5	1·4	62	45·3	42·3	122	89·2	83·2	182	133·1	124·1	242	177·0	165·0
3	2·2	2·0	63	46·1	43·0	123	90·0	83·9	183	133·8	124·8	243	177·7	165·7
4	2·9	2·7	64	46·8	43·6	124	90·7	84·6	184	134·6	125·5	244	178·5	166·4
5	3·7	3·4	65	47·5	44·3	125	91·4	85·2	185	135·3	126·2	245	179·2	167·1
6	4·4	4·1	66	48·3	45·0	126	92·2	85·9	186	136·0	126·9	246	179·9	167·8
7	5·1	4·8	67	49·0	45·7	127	92·9	86·6	187	136·8	127·5	247	180·6	168·5
8	5·9	5·5	68	49·7	46·4	128	93·6	87·3	188	137·5	128·2	248	181·4	169·1
9	6·6	6·1	69	50·5	47·1	129	94·3	88·0	189	138·2	128·9	249	182·1	169·8
10	7·3	6·8	70	51·2	47·7	130	95·1	88·7	190	139·0	129·6	250	182·8	170·5
11	8·0	7·5	71	51·9	48·4	131	95·8	89·3	191	139·7	130·3	251	183·6	171·2
12	8·8	8·2	72	52·7	49·1	132	96·5	90·0	192	140·4	130·9	252	184·3	171·9
13	9·5	8·9	73	53·4	49·8	133	97·3	90·7	193	141·2	131·6	253	185·0	172·5
14	10·2	9·5	74	54·1	50·5	134	98·0	91·4	194	141·9	132·3	254	185·8	173·2
15	11·0	10·2	75	54·9	51·1	135	98·7	92·1	195	142·6	133·0	255	186·5	173·9
16	11·7	10·9	76	55·6	51·8	136	99·5	92·8	196	143·3	133·7	256	187·2	174·6
17	12·4	11·6	77	56·3	52·5	137	100·2	93·4	197	144·1	134·4	257	188·0	175·3
18	13·2	12·3	78	57·0	53·2	138	100·9	94·1	198	144·8	135·0	258	188·7	176·0
19	13·9	13·0	79	57·8	53·9	139	101·7	94·8	199	145·5	135·7	259	189·4	176·6
20	14·6	13·6	80	58·5	54·6	140	102·4	95·5	200	146·3	136·4	260	190·2	177·3
21	15·4	14·3	81	59·2	55·2	141	103·1	96·2	201	147·0	137·1	261	190·9	178·0
22	16·1	15·0	82	60·0	55·9	142	103·9	96·8	202	147·7	137·8	262	191·6	178·7
23	16·8	15·7	83	60·7	56·6	143	104·6	97·5	203	148·5	138·4	263	192·3	179·4
24	17·6	16·4	84	61·4	57·3	144	105·3	98·2	204	149·2	139·1	264	193·1	180·0
25	18·3	17·0	85	62·2	58·0	145	106·0	98·9	205	149·9	139·8	265	193·8	180·7
26	19·0	17·7	86	62·9	58·7	146	106·8	99·6	206	150·7	140·5	266	194·5	181·4
27	19·7	18·4	87	63·6	59·3	147	107·5	100·3	207	151·4	141·2	267	195·3	182·1
28	20·5	19·1	88	64·4	60·0	148	108·2	100·9	208	152·1	141·9	268	196·0	182·8
29	21·2	19·8	89	65·1	60·7	149	109·0	101·6	209	152·9	142·5	269	196·7	183·5
30	21·9	20·5	90	65·8	61·4	150	109·7	102·3	210	153·6	143·2	270	197·5	184·1
31	22·7	21·1	91	66·6	62·1	151	110·4	103·0	211	154·3	143·9	271	198·2	184·8
32	23·4	21·8	92	67·3	62·7	152	111·2	103·7	212	155·0	144·6	272	198·9	185·5
33	24·1	22·5	93	68·0	63·4	153	111·9	104·3	213	155·8	145·3	273	199·7	186·2
34	24·9	23·2	94	68·7	64·1	154	112·6	105·0	214	156·5	145·9	274	200·4	186·9
35	25·6	23·9	95	69·5	64·8	155	113·4	105·7	215	157·2	146·6	275	201·1	187·5
36	26·3	24·6	96	70·2	65·5	156	114·1	106·4	216	158·0	147·3	276	201·9	188·2
37	27·1	25·2	97	70·9	66·2	157	114·8	107·1	217	158·7	148·0	277	202·6	188·9
38	27·8	25·9	98	71·7	66·8	158	115·6	107·8	218	159·4	148·7	278	203·3	189·6
39	28·5	26·6	99	72·4	67·5	159	116·3	108·4	219	160·2	149·4	279	204·0	190·3
40	29·3	27·3	100	73·1	68·2	160	117·0	109·1	220	160·9	150·0	280	204·8	191·0
41	30·0	28·0	101	73·9	68·9	161	117·7	109·8	221	161·6	150·7	281	205·5	191·6
42	30·7	28·6	102	74·6	69·6	162	118·5	110·5	222	162·4	151·4	282	206·2	192·3
43	31·4	29·3	103	75·3	70·2	163	119·2	111·2	223	163·1	152·1	283	207·0	193·0
44	32·2	30·0	104	76·1	70·9	164	119·9	111·8	224	163·8	152·8	284	207·7	193·7
45	32·9	30·7	105	76·8	71·6	165	120·7	112·5	225	164·6	153·4	285	208·4	194·4
46	33·6	31·4	106	77·5	72·3	166	121·4	113·2	226	165·3	154·1	286	209·2	195·1
47	34·4	32·1	107	78·3	73·0	167	122·1	113·9	227	166·0	154·8	287	209·9	195·7
48	35·1	32·7	108	79·0	73·7	168	122·9	114·6	228	166·7	155·5	288	210·6	196·4
49	35·8	33·4	109	79·7	74·3	169	123·6	115·3	229	167·5	156·2	289	211·4	197·1
50	36·6	34·1	110	80·4	75·0	170	124·3	115·9	230	168·2	156·9	290	212·1	197·8
51	37·3	34·8	111	81·2	75·7	171	125·1	116·6	231	168·9	157·5	291	212·8	198·5
52	38·0	35·5	112	81·9	76·4	172	125·8	117·3	232	169·7	158·2	292	213·6	199·1
53	38·8	36·1	113	82·6	77·1	173	126·5	118·0	233	170·4	158·9	293	214·3	199·8
54	39·5	36·8	114	83·4	77·7	174	127·3	118·7	234	171·1	159·6	294	215·0	200·5
55	40·2	37·5	115	84·1	78·4	175	128·0	119·3	235	171·9	160·3	295	215·7	201·2
56	41·0	38·2	116	84·8	79·1	176	128·7	120·0	236	172·6	161·0	296	216·5	201·9
57	41·7	38·9	117	85·6	79·8	177	129·4	120·7	237	173·3	161·6	297	217·2	202·6
58	42·4	39·6	118	86·3	80·5	178	130·2	121·4	238	174·1	162·3	298	217·9	203·2
59	43·1	40·2	119	87·0	81·2	179	130·9	122·1	239	174·8	163·0	299	218·7	203·9
60	43·9	40·9	120	87·8	81·8	180	131·6	122·8	240	175·5	163·7	300	219·4	204·6
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

47° 3h 8m

TRAVERSE TABLE TO DEGREES

43° 2h 52m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	220.1	205.3	361	264.0	246.2	421	307.9	287.1	481	351.8	328.1	541	395.7	369.0
302	220.9	206.0	362	264.8	246.9	422	308.6	287.8	482	352.5	328.7	542	396.4	369.7
303	221.6	206.7	363	265.5	247.6	423	309.4	288.5	483	353.2	329.4	543	397.1	370.3
304	222.3	207.3	364	266.2	248.3	424	310.1	289.2	484	354.0	330.1	544	397.9	371.0
305	223.1	208.0	365	267.0	248.9	425	310.8	289.9	485	354.7	330.8	545	398.6	371.7
306	223.8	208.7	366	267.7	249.6	426	311.6	290.5	486	355.4	331.4	546	399.3	372.4
307	224.5	209.4	367	268.4	250.3	427	312.3	291.2	487	356.2	332.1	547	400.1	373.1
308	225.3	210.1	368	269.1	251.0	428	313.0	291.9	488	356.9	332.8	548	400.8	373.7
309	226.0	210.7	369	269.9	251.7	429	313.8	292.6	489	357.7	333.5	549	401.5	374.4
310	226.7	211.4	370	270.6	252.3	430	314.5	293.3	490	358.4	334.2	550	402.2	375.1
311	227.5	212.1	371	271.3	253.0	431	315.2	293.9	491	359.1	334.9	551	403.0	375.8
312	228.2	212.8	372	272.1	253.7	432	316.0	294.6	492	359.8	335.5	552	403.7	376.5
313	228.9	213.5	373	272.8	254.4	433	316.7	295.3	493	360.6	336.2	553	404.4	377.1
314	229.7	214.2	374	273.5	255.1	434	317.4	296.0	494	361.3	336.9	554	405.2	377.8
315	230.4	214.8	375	274.3	255.8	435	318.1	296.7	495	362.0	337.6	555	405.9	378.5
316	231.1	215.5	376	275.0	256.4	436	318.9	297.4	496	362.8	338.3	556	406.6	379.2
317	231.8	216.2	377	275.7	257.1	437	319.6	298.0	497	363.5	338.9	557	407.4	379.9
318	232.6	216.9	378	276.5	257.8	438	320.3	298.7	498	364.2	339.6	558	408.1	380.6
319	233.3	217.6	379	277.2	258.5	439	321.1	299.4	499	364.9	340.3	559	408.8	381.2
320	234.0	218.2	380	277.9	259.2	440	321.8	300.1	500	365.7	341.0	560	409.6	381.9
321	234.8	218.9	381	278.7	259.8	441	322.5	300.8	501	366.4	341.7	561	410.3	382.6
322	235.5	219.6	382	279.4	260.5	442	323.3	301.4	502	367.1	342.4	562	411.0	383.3
323	236.2	220.3	383	280.1	261.2	443	324.0	302.1	503	367.8	343.0	563	411.8	384.0
324	237.0	221.0	384	280.8	261.9	444	324.7	302.8	504	368.6	343.7	564	412.5	384.6
325	237.7	221.7	385	281.6	262.6	445	325.5	303.5	505	369.3	344.4	565	413.2	385.3
326	238.4	222.3	386	282.3	263.3	446	326.2	304.2	506	370.0	345.1	566	414.0	386.0
327	239.2	223.0	387	283.0	263.9	447	326.9	304.9	507	370.8	345.8	567	414.7	386.7
328	239.9	223.7	388	283.7	264.6	448	327.7	305.5	508	371.5	346.5	568	415.4	387.4
329	240.6	224.4	389	284.5	265.3	449	328.4	306.2	509	372.3	347.1	569	416.2	388.1
330	241.4	225.1	390	285.2	266.0	450	329.1	306.9	510	373.0	347.8	570	416.9	388.7
331	242.1	225.7	391	286.0	266.7	451	329.9	307.6	511	373.8	348.5	571	417.6	389.4
332	242.8	226.4	392	286.7	267.3	452	330.6	308.3	512	374.5	349.2	572	418.3	390.1
333	243.5	227.1	393	287.4	268.0	453	331.3	309.0	513	375.2	349.9	573	419.1	390.8
334	244.3	227.8	394	288.2	268.7	454	332.1	309.6	514	376.0	350.5	574	419.8	391.5
335	245.0	228.5	395	288.9	269.4	455	332.8	310.3	515	376.6	351.2	575	420.5	392.2
336	245.7	229.2	396	289.6	270.1	456	333.5	311.0	516	377.4	351.9	576	421.3	392.8
337	246.5	229.8	397	290.4	270.8	457	334.3	311.7	517	378.2	352.6	577	422.0	393.5
338	247.2	230.5	398	291.1	271.4	458	335.0	312.4	518	378.9	353.3	578	422.7	394.2
339	247.9	231.2	399	291.8	272.1	459	335.7	313.0	519	379.6	354.0	579	423.5	394.9
340	248.7	231.9	400	292.6	272.8	460	336.5	313.7	520	380.3	354.6	580	424.2	395.6
341	249.4	232.6	401	293.3	273.5	461	337.2	314.4	521	381.1	355.3	581	424.9	396.2
342	250.1	233.2	402	294.0	274.2	462	337.9	315.1	522	381.8	356.0	582	425.7	396.9
343	250.9	233.9	403	294.7	274.9	463	338.7	315.8	523	382.6	356.7	583	426.4	397.6
344	251.6	234.6	404	295.5	275.5	464	339.4	316.5	524	383.3	357.4	584	427.1	398.3
345	252.3	235.3	405	296.2	276.2	465	340.1	317.1	525	384.0	358.1	585	427.9	399.0
346	253.1	236.0	406	296.9	276.9	466	340.8	317.8	526	384.7	358.7	586	428.6	399.6
347	253.8	236.7	407	297.7	277.6	467	341.6	318.5	527	385.5	359.4	587	429.3	400.3
348	254.5	237.3	408	298.4	278.3	468	342.3	319.2	528	386.2	360.1	588	430.1	401.0
349	255.3	238.0	409	299.1	278.9	469	343.0	319.9	529	386.9	360.8	589	430.8	401.7
350	256.0	238.7	410	299.9	279.6	470	343.7	320.5	530	387.6	361.5	590	431.5	402.4
351	256.7	239.4	411	300.6	280.3	471	344.5	321.2	531	388.4	362.1	591	432.3	403.1
352	257.4	240.1	412	301.3	281.0	472	345.2	321.9	532	389.1	362.8	592	433.0	403.7
353	258.2	240.8	413	302.1	281.7	473	345.9	322.6	533	389.9	363.5	593	433.7	404.4
354	258.9	241.4	414	302.8	282.4	474	346.7	323.3	534	390.6	364.2	594	434.5	405.1
355	259.6	242.1	415	303.5	283.0	475	347.4	324.0	535	391.3	364.9	595	435.2	405.8
356	260.4	242.8	416	304.3	283.7	476	348.1	324.6	536	392.0	365.5	596	435.9	406.5
357	261.1	243.5	417	305.0	284.4	477	348.9	325.3	537	392.8	366.2	597	436.7	407.2
358	261.8	244.2	418	305.7	285.1	478	349.6	326.0	538	393.5	366.9	598	437.4	407.8
359	262.6	244.8	419	306.4	285.8	479	350.3	326.7	539	394.2	367.6	599	438.1	408.5
360	263.3	245.5	420	307.2	286.4	480	351.1	327.4	540	394.9	368.3	600	438.8	409.2
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

47° 3h 8m

TRAVERSE TABLE TO DEGREES

44° 2h 56m

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·7	0·7	61	43·9	42·4	121	87·0	84·1	181	130·2	125·7	241	173·4	167·4
2	1·4	1·4	62	44·6	43·1	122	87·8	84·7	182	130·9	126·4	242	174·1	168·1
3	2·2	2·1	63	45·3	43·8	123	88·5	85·4	183	131·6	127·1	243	174·8	168·8
4	2·9	2·8	64	46·0	44·5	124	89·2	86·1	184	132·4	127·8	244	175·5	169·5
5	3·6	3·5	65	46·8	45·2	125	89·9	86·8	185	133·1	128·5	245	176·2	170·2
6	4·3	4·2	66	47·5	45·8	126	90·6	87·5	186	133·8	129·2	246	177·0	170·9
7	5·0	4·9	67	48·2	46·5	127	91·4	88·2	187	134·5	129·9	247	177·7	171·6
8	5·8	5·6	68	48·9	47·2	128	92·1	88·9	188	135·2	130·6	248	178·4	172·3
9	6·5	6·3	69	49·6	47·9	129	92·8	89·6	189	136·0	131·3	249	179·1	173·0
10	7·2	6·9	70	50·4	48·6	130	93·5	90·3	190	136·7	132·0	250	179·8	173·7
11	7·9	7·6	71	51·1	49·3	131	94·2	91·0	191	137·4	132·7	251	180·6	174·4
12	8·6	8·3	72	51·8	50·0	132	95·0	91·7	192	138·1	133·4	252	181·3	175·1
13	9·4	9·0	73	52·5	50·7	133	95·7	92·4	193	138·8	134·1	253	182·0	175·7
14	10·1	9·7	74	53·2	51·4	134	96·4	93·1	194	139·6	134·8	254	182·7	176·4
15	10·8	10·4	75	54·0	52·1	135	97·1	93·8	195	140·3	135·5	255	183·4	177·1
16	11·5	11·1	76	54·7	52·8	136	97·8	94·5	196	141·0	136·2	256	184·2	177·8
17	12·2	11·8	77	55·4	53·5	137	98·5	95·2	197	141·7	136·8	257	184·9	178·5
18	12·9	12·5	78	56·1	54·2	138	99·3	95·9	198	142·4	137·5	258	185·6	179·2
19	13·7	13·2	79	56·8	54·9	139	100·0	96·6	199	143·1	138·2	259	186·3	179·9
20	14·4	13·9	80	57·5	55·6	140	100·7	97·3	200	143·9	138·9	260	187·0	180·6
21	15·1	14·6	81	58·3	56·3	141	101·4	97·9	201	144·6	139·6	261	187·7	181·3
22	15·8	15·3	82	59·0	57·0	142	102·1	98·6	202	145·3	140·3	262	188·5	182·0
23	16·5	16·0	83	59·7	57·7	143	102·9	99·3	203	146·0	141·0	263	189·2	182·7
24	17·3	16·7	84	60·4	58·4	144	103·6	100·0	204	146·7	141·7	264	189·9	183·4
25	18·0	17·4	85	61·1	59·0	145	104·3	100·7	205	147·5	142·4	265	190·6	184·1
26	18·7	18·1	86	61·9	59·7	146	105·0	101·4	206	148·2	143·1	266	191·3	184·8
27	19·4	18·8	87	62·6	60·4	147	105·7	102·1	207	148·9	143·8	267	192·1	185·5
28	20·1	19·5	88	63·3	61·1	148	106·5	102·8	208	149·6	144·5	268	192·8	186·2
29	20·9	20·1	89	64·0	61·8	149	107·2	103·5	209	150·3	145·2	269	193·5	186·9
30	21·6	20·8	90	64·7	62·5	150	107·9	104·2	210	151·1	145·9	270	194·2	187·6
31	22·3	21·5	91	65·5	63·2	151	108·6	104·9	211	151·8	146·6	271	194·9	188·3
32	23·0	22·2	92	66·2	63·9	152	109·3	105·6	212	152·5	147·3	272	195·7	188·9
33	23·7	22·9	93	66·9	64·6	153	110·1	106·3	213	153·2	148·0	273	196·4	189·6
34	24·5	23·6	94	67·6	65·3	154	110·8	107·0	214	153·9	148·7	274	197·1	190·3
35	25·2	24·3	95	68·3	66·0	155	111·5	107·7	215	154·7	149·4	275	197·8	191·0
36	25·9	25·0	96	69·1	66·7	156	112·2	108·4	216	155·4	150·0	276	198·5	191·7
37	26·6	25·7	97	69·8	67·4	157	112·9	109·1	217	156·1	150·7	277	199·3	192·4
38	27·3	26·4	98	70·5	68·1	158	113·7	109·8	218	156·8	151·4	278	200·0	193·1
39	28·1	27·1	99	71·2	68·8	159	114·4	110·5	219	157·5	152·1	279	200·7	193·8
40	28·8	27·8	100	71·9	69·5	160	115·1	111·1	220	158·3	152·8	280	201·4	194·5
41	29·5	28·5	101	72·7	70·2	161	115·8	111·8	221	159·0	153·5	281	202·1	195·2
42	30·2	29·2	102	73·4	70·9	162	116·5	112·5	222	159·7	154·2	282	202·9	195·9
43	30·9	29·9	103	74·1	71·5	163	117·3	113·2	223	160·4	154·9	283	203·6	196·6
44	31·7	30·6	104	74·8	72·2	164	118·0	113·9	224	161·1	155·6	284	204·3	197·3
45	32·4	31·3	105	75·5	72·9	165	118·7	114·6	225	161·9	156·3	285	205·0	198·0
46	33·1	32·0	106	76·3	73·6	166	119·4	115·3	226	162·6	157·0	286	205·7	198·7
47	33·8	32·6	107	77·0	74·3	167	120·1	116·0	227	163·3	157·7	287	206·5	199·4
48	34·5	33·3	108	77·7	75·0	168	120·8	116·7	228	164·0	158·4	288	207·2	200·1
49	35·2	34·0	109	78·4	75·7	169	121·6	117·4	229	164·7	159·1	289	207·9	200·8
50	36·0	34·7	110	79·1	76·4	170	122·3	118·1	230	165·4	159·8	290	208·6	201·5
51	36·7	35·4	111	79·8	77·1	171	123·0	118·8	231	166·2	160·5	291	209·3	202·1
52	37·4	36·1	112	80·6	77·8	172	123·7	119·5	232	166·9	161·2	292	210·0	202·8
53	38·1	36·8	113	81·3	78·5	173	124·4	120·2	233	167·6	161·9	293	210·8	203·5
54	38·8	37·5	114	82·0	79·2	174	125·2	120·9	234	168·3	162·6	294	211·5	204·2
55	39·6	38·2	115	82·7	79·9	175	125·9	121·6	235	169·0	163·2	295	212·2	204·9
56	40·3	38·9	116	83·4	80·6	176	126·6	122·3	236	169·8	163·9	296	212·9	205·6
57	41·0	39·6	117	84·2	81·3	177	127·3	123·0	237	170·5	164·6	297	213·6	206·3
58	41·7	40·3	118	84·9	82·0	178	128·0	123·6	238	171·2	165·3	298	214·4	207·0
59	42·4	41·0	119	85·6	82·7	179	128·8	124·3	239	171·9	166·0	299	215·1	207·7
60	43·2	41·7	120	86·3	83·4	180	129·5	125·0	240	172·6	166·7	300	215·8	208·4
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

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TRAVERSE TABLE TO DEGREES

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Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	216·5	209·1	361	259·7	250·8	421	302·8	292·5	481	346·0	334·1	541	389·2	375·8
302	217·2	209·8	362	260·4	251·5	422	303·6	293·2	482	346·7	334·8	542	389·9	376·5
303	218·0	210·5	363	261·1	252·2	423	304·3	293·8	483	347·4	335·5	543	390·6	377·2
304	218·7	211·2	364	261·8	252·9	424	305·0	294·5	484	348·2	336·2	544	391·3	377·9
305	219·4	211·9	365	262·6	253·6	425	305·7	295·2	485	348·9	336·9	545	392·0	378·6
306	220·1	212·6	366	263·3	254·3	426	306·4	295·9	486	349·6	337·6	546	392·8	379·3
307	220·8	213·3	367	264·0	254·9	427	307·2	296·6	487	350·3	338·3	547	393·5	380·0
308	221·6	214·0	368	264·7	255·6	428	307·9	297·3	488	351·0	339·0	548	394·2	380·7
309	222·3	214·7	369	265·4	256·3	429	308·6	298·0	489	351·7	339·7	549	394·9	381·4
310	223·0	215·4	370	266·2	257·0	430	309·3	298·7	490	352·5	340·4	550	395·6	382·1
311	223·7	216·0	371	266·9	257·7	431	310·0	299·4	491	353·2	341·1	551	396·4	382·7
312	224·4	216·7	372	267·6	258·4	432	310·8	300·1	492	353·9	341·8	552	397·1	383·4
313	225·2	217·4	373	268·3	259·1	433	311·5	300·8	493	354·6	342·5	553	397·8	384·1
314	225·9	218·1	374	269·0	259·8	434	312·2	301·5	494	355·3	343·2	554	398·5	384·8
315	226·6	218·8	375	269·8	260·5	435	312·9	302·2	495	356·1	343·9	555	399·2	385·5
316	227·3	219·5	376	270·5	261·2	436	313·6	302·9	496	356·8	344·6	556	400·0	386·2
317	228·0	220·2	377	271·2	261·9	437	314·4	303·6	497	357·5	345·2	557	400·7	386·9
318	228·8	220·9	378	271·9	262·6	438	315·1	304·3	498	358·2	345·9	558	401·4	387·6
319	229·5	221·6	379	272·6	263·3	439	315·8	305·0	499	358·9	346·6	559	402·1	388·3
320	230·2	222·3	380	273·4	264·0	440	316·5	305·7	500	359·7	347·3	560	402·8	389·0
321	230·9	223·0	381	274·1	264·7	441	317·2	306·4	501	360·4	348·0	561	403·6	389·7
322	231·6	223·7	382	274·8	265·4	442	318·0	307·0	502	361·1	348·7	562	404·3	390·4
323	232·3	224·4	383	275·5	266·1	443	318·7	307·7	503	361·8	349·4	563	405·0	391·1
324	233·1	225·1	384	276·2	266·8	444	319·4	308·4	504	362·5	350·1	564	405·7	391·8
325	233·8	225·8	385	276·9	267·5	445	320·1	309·1	505	363·3	350·8	565	406·4	392·5
326	234·5	226·5	386	277·7	268·1	446	320·8	309·8	506	364·0	351·5	566	407·2	393·2
327	235·2	227·2	387	278·4	268·8	447	321·5	310·5	507	364·7	352·2	567	407·9	393·9
328	235·9	227·9	388	279·1	269·5	448	322·3	311·2	508	365·4	352·9	568	408·6	394·6
329	236·7	228·6	389	279·8	270·2	449	323·0	311·9	509	366·1	353·6	569	409·3	395·3
330	237·4	229·2	390	280·5	270·9	450	323·7	312·6	510	366·9	354·3	570	410·0	396·0
331	238·1	229·9	391	281·3	271·6	451	324·4	313·3	511	367·6	355·0	571	410·7	396·7
332	238·8	230·6	392	282·0	272·3	452	325·2	314·0	512	368·3	355·7	572	411·5	397·3
333	239·5	231·3	393	282·7	273·0	453	325·9	314·7	513	369·0	356·4	573	412·2	398·0
334	240·3	232·0	394	283·4	273·7	454	326·6	315·4	514	369·7	357·1	574	412·9	398·7
335	241·0	232·7	395	284·1	274·4	455	327·3	316·1	515	370·5	357·8	575	413·6	399·4
336	241·7	233·4	396	284·9	275·1	456	328·0	316·8	516	371·2	358·4	576	414·3	400·1
337	242·4	234·1	397	285·6	275·8	457	328·7	317·5	517	371·9	359·1	577	415·1	400·8
338	243·1	234·8	398	286·3	276·5	458	329·5	318·2	518	372·6	359·8	578	415·8	401·5
339	243·9	235·5	399	287·0	277·2	459	330·2	318·9	519	373·3	360·5	579	416·5	402·2
340	244·6	236·2	400	287·7	277·9	460	330·9	319·6	520	374·1	361·2	580	417·2	402·9
341	245·3	236·9	401	288·5	278·6	461	331·6	320·2	521	374·8	361·9	581	417·9	403·6
342	246·0	237·6	402	289·2	279·3	462	332·3	320·9	522	375·5	362·6	582	418·7	404·3
343	246·7	238·3	403	289·9	280·0	463	333·1	321·6	523	376·2	363·3	583	419·4	405·0
344	247·5	239·0	404	290·6	280·7	464	333·8	322·3	524	376·9	364·0	584	420·1	405·7
345	248·2	239·7	405	291·3	281·3	465	334·5	323·0	525	377·7	364·7	585	420·8	406·4
346	248·9	240·4	406	292·1	282·0	466	335·2	323·7	526	378·4	365·4	586	421·5	407·1
347	249·6	241·1	407	292·8	282·7	467	335·9	324·4	527	379·1	366·1	587	422·3	407·8
348	250·3	241·7	408	293·5	283·4	468	336·7	325·1	528	379·8	366·8	588	423·0	408·5
349	251·1	242·4	409	294·2	284·1	469	337·4	325·8	529	380·5	367·5	589	423·7	409·1
350	251·8	243·1	410	294·9	284·8	470	338·1	326·5	530	381·2	368·2	590	424·4	409·9
351	252·5	243·8	411	295·7	285·5	471	338·8	327·2	531	382·0	368·9	591	425·1	410·5
352	253·2	244·5	412	296·4	286·2	472	339·5	327·9	532	382·7	369·6	592	425·9	411·2
353	253·9	245·2	413	297·1	286·9	473	340·3	328·6	533	383·4	370·3	593	426·6	411·9
354	254·6	245·9	414	297·8	287·6	474	341·0	329·3	534	384·1	371·0	594	427·3	412·6
355	255·4	246·6	415	298·5	288·3	475	341·7	330·0	535	384·8	371·7	595	428·0	413·3
356	256·1	247·3	416	299·2	289·0	476	342·4	330·7	536	385·6	372·4	596	428·7	414·0
357	256·8	248·0	417	300·0	289·7	477	343·1	331·4	537	386·3	373·1	597	429·5	414·7
358	257·5	248·7	418	300·7	290·4	478	343·8	332·1	538	387·0	373·7	598	430·2	415·4
359	258·2	249·4	419	301·4	291·1	479	344·6	332·7	539	387·7	374·4	599	430·9	416·1
360	259·0	250·1	420	302·1	291·8	480	345·3	333·4	540	388·4	375·1	600	431·6	416·8
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

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TRAVERSE TABLE TO DEGREES

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Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0·7	0·7	61	43·1	43·1	121	85·6	85·6	181	128·0	128·0	241	170·4	170·4
2	1·4	1·4	62	43·8	43·8	122	86·3	86·3	182	128·7	128·7	242	171·1	171·1
3	2·1	2·1	63	44·5	44·5	123	87·0	87·0	183	129·4	129·4	243	171·8	171·8
4	2·8	2·8	64	45·3	45·3	124	87·7	87·7	184	130·1	130·1	244	172·5	172·5
5	3·5	3·5	65	46·0	46·0	125	88·4	88·4	185	130·8	130·8	245	173·2	173·2
6	4·2	4·2	66	46·7	46·7	126	89·1	89·1	186	131·5	131·5	246	173·9	173·9
7	4·9	4·9	67	47·4	47·4	127	89·8	89·8	187	132·2	132·2	247	174·7	174·7
8	5·7	5·7	68	48·1	48·1	128	90·5	90·5	188	132·9	132·9	248	175·4	175·4
9	6·4	6·4	69	48·8	48·8	129	91·2	91·2	189	133·6	133·6	249	176·1	176·1
10	7·1	7·1	70	49·5	49·5	130	91·9	91·9	190	134·4	134·4	250	176·8	176·8
11	7·8	7·8	71	50·2	50·2	131	92·6	92·6	191	135·1	135·1	251	177·5	177·5
12	8·5	8·5	72	50·9	50·9	132	93·3	93·3	192	135·8	135·8	252	178·2	178·2
13	9·2	9·2	73	51·6	51·6	133	94·0	94·0	193	136·5	136·5	253	178·9	178·9
14	9·9	9·9	74	52·3	52·3	134	94·8	94·8	194	137·2	137·2	254	179·6	179·6
15	10·6	10·6	75	53·0	53·0	135	95·5	95·5	195	137·9	137·9	255	180·3	180·3
16	11·3	11·3	76	53·7	53·7	136	96·2	96·2	196	138·6	138·6	256	181·0	181·0
17	12·0	12·0	77	54·4	54·4	137	96·9	96·9	197	139·3	139·3	257	181·7	181·7
18	12·7	12·7	78	55·2	55·2	138	97·6	97·6	198	140·0	140·0	258	182·4	182·4
19	13·4	13·4	79	55·9	55·9	139	98·3	98·3	199	140·7	140·7	259	183·1	183·1
20	14·1	14·1	80	56·6	56·6	140	99·0	99·0	200	141·4	141·4	260	183·8	183·8
21	14·8	14·8	81	57·3	57·3	141	99·7	99·7	201	142·1	142·1	261	184·6	184·6
22	15·6	15·6	82	58·0	58·0	142	100·4	100·4	202	142·8	142·8	262	185·3	185·3
23	16·3	16·3	83	58·7	58·7	143	101·1	101·1	203	143·5	143·5	263	186·0	186·0
24	17·0	17·0	84	59·4	59·4	144	101·8	101·8	204	144·2	144·2	264	186·7	186·7
25	17·7	17·7	85	60·1	60·1	145	102·5	102·5	205	145·0	145·0	265	187·4	187·4
26	18·4	18·4	86	60·8	60·8	146	103·2	103·2	206	145·7	145·7	266	188·1	188·1
27	19·1	19·1	87	61·5	61·5	147	103·9	103·9	207	146·4	146·4	267	188·8	188·8
28	19·8	19·8	88	62·2	62·2	148	104·7	104·7	208	147·1	147·1	268	189·5	189·5
29	20·5	20·5	89	62·9	62·9	149	105·4	105·4	209	147·8	147·8	269	190·2	190·2
30	21·2	21·2	90	63·6	63·6	150	106·1	106·1	210	148·5	148·5	270	190·9	190·9
31	21·9	21·9	91	64·3	64·3	151	106·8	106·8	211	149·2	149·2	271	191·6	191·6
32	22·6	22·6	92	65·1	65·1	152	107·5	107·5	212	149·9	149·9	272	192·3	192·3
33	23·3	23·3	93	65·8	65·8	153	108·2	108·2	213	150·6	150·6	273	193·0	193·0
34	24·0	24·0	94	66·5	66·5	154	108·9	108·9	214	151·3	151·3	274	193·7	193·7
35	24·7	24·7	95	67·2	67·2	155	109·6	109·6	215	152·0	152·0	275	194·5	194·5
36	25·5	25·5	96	67·9	67·9	156	110·3	110·3	216	152·7	152·7	276	195·2	195·2
37	26·2	26·2	97	68·6	68·6	157	111·0	111·0	217	153·4	153·4	277	195·9	195·9
38	26·9	26·9	98	69·3	69·3	158	111·7	111·7	218	154·1	154·1	278	196·6	196·6
39	27·6	27·6	99	70·0	70·0	159	112·4	112·4	219	154·9	154·9	279	197·3	197·3
40	28·3	28·3	100	70·7	70·7	160	113·1	113·1	220	155·6	155·6	280	198·0	198·0
41	29·0	29·0	101	71·4	71·4	161	113·8	113·8	221	156·3	156·3	281	198·7	198·7
42	29·7	29·7	102	72·1	72·1	162	114·6	114·6	222	157·0	157·0	282	199·4	199·4
43	30·4	30·4	103	72·8	72·8	163	115·3	115·3	223	157·7	157·7	283	200·1	200·1
44	31·1	31·1	104	73·5	73·5	164	116·0	116·0	224	158·4	158·4	284	200·8	200·8
45	31·8	31·8	105	74·2	74·2	165	116·7	116·7	225	159·1	159·1	285	201·5	201·5
46	32·5	32·5	106	75·0	75·0	166	117·4	117·4	226	159·8	159·8	286	202·2	202·2
47	33·2	33·2	107	75·7	75·7	167	118·1	118·1	227	160·5	160·5	287	202·9	202·9
48	33·9	33·9	108	76·4	76·4	168	118·8	118·8	228	161·2	161·2	288	203·6	203·6
49	34·6	34·6	109	77·1	77·1	169	119·5	119·5	229	161·9	161·9	289	204·4	204·4
50	35·4	35·4	110	77·8	77·8	170	120·2	120·2	230	162·6	162·6	290	205·1	205·1
51	36·1	36·1	111	78·5	78·5	171	120·9	120·9	231	163·3	163·3	291	205·8	205·8
52	36·8	36·8	112	79·2	79·2	172	121·6	121·6	232	164·0	164·0	292	206·5	206·5
53	37·5	37·5	113	79·9	79·9	173	122·3	122·3	233	164·8	164·8	293	207·2	207·2
54	38·2	38·2	114	80·6	80·6	174	123·0	123·0	234	165·5	165·5	294	207·9	207·9
55	38·9	38·9	115	81·3	81·3	175	123·7	123·7	235	166·2	166·2	295	208·6	208·6
56	39·6	39·6	116	82·0	82·0	176	124·5	124·5	236	166·9	166·9	296	209·3	209·3
57	40·3	40·3	117	82·7	82·7	177	125·2	125·2	237	167·6	167·6	297	210·0	210·0
58	41·0	41·0	118	83·4	83·4	178	125·9	125·9	238	168·3	168·3	298	210·7	210·7
59	41·7	41·7	119	84·1	84·1	179	126·6	126·6	239	169·0	169·0	299	211·4	211·4
60	42·4	42·4	120	84·9	84·9	180	127·3	127·3	240	169·7	169·7	300	212·1	212·1
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

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Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
301	212·8	212·8	361	255·3	255·3	421	297·7	297·7	481	340·1	340·1	541	382·5	382·5
302	213·5	213·5	362	256·0	256·0	422	298·4	298·4	482	340·8	340·8	542	383·2	383·2
303	214·3	214·3	363	256·7	256·7	423	299·1	299·1	483	341·5	341·5	543	383·9	383·9
304	215·0	215·0	364	257·4	257·4	424	299·8	299·8	484	342·2	342·2	544	384·7	384·7
305	215·7	215·7	365	258·1	258·1	425	300·5	300·5	485	342·9	342·9	545	385·4	385·4
306	216·4	216·4	366	258·8	258·8	426	301·2	301·2	486	343·6	343·6	546	386·1	386·1
307	217·1	217·1	367	259·5	259·5	427	301·9	301·9	487	344·3	344·3	547	386·8	386·8
308	217·8	217·8	368	260·2	260·2	428	302·6	302·6	488	345·1	345·1	548	387·5	387·5
309	218·5	218·5	369	260·9	260·9	429	303·4	303·4	489	345·8	345·8	549	388·2	388·2
310	219·2	219·2	370	261·6	261·6	430	304·1	304·1	490	346·5	346·5	550	388·9	388·9
311	219·9	219·9	371	262·3	262·3	431	304·8	304·8	491	347·2	347·2	551	389·6	389·6
312	220·6	220·6	372	263·0	263·0	432	305·5	305·5	492	347·9	347·9	552	390·3	390·3
313	221·3	221·3	373	263·8	263·8	433	306·2	306·2	493	348·6	348·6	553	391·0	391·0
314	222·0	222·0	374	264·5	264·5	434	306·9	306·9	494	349·3	349·3	554	391·7	391·7
315	222·7	222·7	375	265·2	265·2	435	307·6	307·6	495	350·0	350·0	555	392·4	392·4
316	223·4	223·4	376	265·9	265·9	436	308·3	308·3	496	350·7	350·7	556	393·1	393·1
317	224·2	224·2	377	266·6	266·6	437	309·0	309·0	497	351·4	351·4	557	393·9	393·9
318	224·9	224·9	378	267·3	267·3	438	309·7	309·7	498	352·1	352·1	558	394·6	394·6
319	225·6	225·6	379	268·0	268·0	439	310·4	310·4	499	352·8	352·8	559	395·3	395·3
320	226·3	226·3	380	268·7	268·7	440	311·1	311·1	500	353·5	353·5	560	396·0	396·0
321	227·0	227·0	381	269·4	269·4	441	311·8	311·8	501	354·3	354·3	561	396·7	396·7
322	227·7	227·7	382	270·1	270·1	442	312·5	312·5	502	355·0	355·0	562	397·4	397·4
323	228·4	228·4	383	270·8	270·8	443	313·3	313·3	503	355·7	355·7	563	398·1	398·1
324	229·1	229·1	384	271·5	271·5	444	314·0	314·0	504	356·4	356·4	564	398·8	398·8
325	229·8	229·8	385	272·2	272·2	445	314·7	314·7	505	357·1	357·1	565	399·5	399·5
326	230·5	230·5	386	272·9	272·9	446	315·4	315·4	506	357·8	357·8	566	400·2	400·2
327	231·2	231·2	387	273·7	273·7	447	316·1	316·1	507	358·5	358·5	567	400·9	400·9
328	231·9	231·9	388	274·4	274·4	448	316·8	316·8	508	359·2	359·2	568	401·6	401·6
329	232·6	232·6	389	275·1	275·1	449	317·5	317·5	509	359·9	359·9	569	402·3	402·3
330	233·3	233·3	390	275·8	275·8	450	318·2	318·2	510	360·6	360·6	570	403·0	403·0
331	234·1	234·1	391	276·5	276·5	451	318·9	318·9	511	361·3	361·3	571	403·8	403·8
332	234·8	234·8	392	277·2	277·2	452	319·6	319·6	512	362·0	362·0	572	404·5	404·5
333	235·5	235·5	393	277·9	277·9	453	320·3	320·3	513	362·7	362·7	573	405·2	405·2
334	236·2	236·2	394	278·6	278·6	454	321·0	321·0	514	363·5	363·5	574	405·9	405·9
335	236·9	236·9	395	279·3	279·3	455	321·7	321·7	515	364·2	364·2	575	406·6	406·6
336	237·6	237·6	396	280·0	280·0	456	322·4	322·4	516	364·9	364·9	576	407·3	407·3
337	238·3	238·3	397	280·7	280·7	457	323·2	323·2	517	365·6	365·6	577	408·0	408·0
338	239·0	239·0	398	281·4	281·4	458	323·9	323·9	518	366·3	366·3	578	408·7	408·7
339	239·7	239·7	399	282·1	282·1	459	324·6	324·6	519	367·0	367·0	579	409·4	409·4
340	240·4	240·4	400	282·8	282·8	460	325·3	325·3	520	367·7	367·7	580	410·1	410·1
341	241·1	241·1	401	283·6	283·6	461	326·0	326·0	521	368·4	368·4	581	410·8	410·8
342	241·8	241·8	402	284·3	284·3	462	326·7	326·7	522	369·1	369·1	582	411·5	411·5
343	242·5	242·5	403	285·0	285·0	463	327·4	327·4	523	369·8	369·8	583	412·2	412·2
344	243·2	243·2	404	285·7	285·7	464	328·1	328·1	524	370·5	370·5	584	412·9	412·9
345	244·0	244·0	405	286·4	286·4	465	328·8	328·8	525	371·2	371·2	585	413·7	413·7
346	244·7	244·7	406	287·1	287·1	466	329·5	329·5	526	371·9	371·9	586	414·4	414·4
347	245·4	245·4	407	287·8	287·8	467	330·2	330·2	527	372·6	372·6	587	415·1	415·1
348	246·1	246·1	408	288·5	288·5	468	330·9	330·9	528	373·4	373·4	588	415·8	415·8
349	246·8	246·8	409	289·2	289·2	469	331·6	331·6	529	374·1	374·1	589	416·5	416·5
350	247·5	247·5	410	289·9	289·9	470	332·3	332·3	530	374·8	374·8	590	417·2	417·2
351	248·2	248·2	411	290·6	290·6	471	333·1	333·1	531	375·5	375·5	591	417·9	417·9
352	248·9	248·9	412	291·3	291·3	472	333·8	333·8	532	376·2	376·2	592	418·6	418·6
353	249·6	249·6	413	292·0	292·0	473	334·5	334·5	533	376·9	376·9	593	419·3	419·3
354	250·3	250·3	414	292·7	292·7	474	335·2	335·2	534	377·6	377·6	594	420·0	420·0
355	251·0	251·0	415	293·5	293·5	475	335·9	335·9	535	378·3	378·3	595	420·7	420·7
356	251·7	251·7	416	294·2	294·2	476	336·6	336·6	536	379·0	379·0	596	421·4	421·4
357	252·4	252·4	417	294·9	294·9	477	337·3	337·3	537	379·7	379·7	597	422·1	422·1
358	253·1	253·1	418	295·6	295·6	478	338·0	338·0	538	380·4	380·4	598	422·8	422·8
359	253·9	253·9	419	296·3	296·3	479	338·7	338·7	539	381·1	381·1	599	423·6	423·6
360	254·6	254·6	420	297·0	297·0	480	339·4	339·4	540	381·8	381·8	600	424·3	424·3
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

45° 3h 0m

DEPARTURE AND CORRESPONDING DIFFERENCE OF LONGITUDE

Lat.	Departure										Parts			
	1	2	3	4	5	6	7	8	9	10	D to 1°	15′	30′	45′
0°	1·00	2·00	3·00	4·00	5·00	6·00	7·00	8·00	9·00	10·00	0·04	0·01	0·02	0·03
4	1·00	2·00	3·01	4·01	5·01	6·01	7·02	8·02	9·02	10·02	0·08	0·02	0·04	0·06
6	1·01	2·01	3·02	4·02	5·03	6·03	7·04	8·04	9·05	10·06	0·12	0·03	0·06	0·09
8	1·01	2·02	3·03	4·04	5·05	6·06	7·07	8·08	9·09	10·10	0·14	0·03	0·07	0·10
10	1·02	2·03	3·05	4·06	5·08	6·09	7·11	8·11	9·14	10·15	0·16	0·04	0·08	0·12
12	1·02	2·04	3·07	4·09	5·11	6·13	7·16	8·18	9·20	10·22	0·18	0·04	0·08	0·13
14	1·03	2·06	3·09	4·12	5·15	6·18	7·21	8·24	9·28	10·31	0·20	0·05	0·10	0·15
15	1·04	2·07	3·11	4·14	5·18	6·21	7·25	8·28	9·32	10·35	0·22	0.05	0·11	0·16
16	1·04	2·08	3·12	4·16	5·20	6·24	7·28	8·32	9·36	10·40	0·24	0·06	0·12	0·18
17	1·05	2·09	3·14	4·18	5·23	6·27	7·32	8·37	9·41	10·46	0·26	0·06	0·13	0·19
18	1·05	2·10	3·15	4·21	5·26	6·31	7·36	8·41	9·46	10·51	0·28	0·07	0·14	0·21
19	1·06	2·12	3·17	4·23	5·29	6·35	7·40	8·46	9·52	10·58	0·30	0·07	0·15	0·22
20	1·06	2·13	3·19	4·26	5·32	6·39	7·45	8·51	9·58	10·64	0·32	0·08	0·16	0·24
21	1·07	2·14	3·21	4·28	5·36	6·43	7·50	8·57	9·64	10·71	0·34	0·08	0·17	0·25
22	1·08	2·16	3·24	4·31	5·39	6·47	7·55	8·63	9·71	10·79	0·36	0·09	0·18	0·27
23	1·09	2·17	3·26	4·35	5·43	6·52	7·60	8·69	9·78	10·86	0·38	0·09	0·19	0·28
24	1·09	2·19	3·28	4·38	5·47	6·57	7·66	8·76	9·85	10·95	0·40	0·10	0·20	0·30
25	1·10	2·21	3·31	4·41	5·52	6·62	7·72	8·83	9·93	11·03	0·42	0·10	0·21	0·31
26	1·11	2·23	3·34	4·45	5·56	6·68	7·79	8·90	10·01	11·13	0·44	0·11	0·22	0·33
27	1·12	2·24	3·37	4·49	5·61	6·73	7·86	8·98	10·10	11·22	0·46	0·11	0·23	0·34
28	1·13	2·27	3·40	4·53	5·66	6·80	7·93	9·06	10·19	11·33	0·48	0·12	0·24	0·36
29	1·14	2·29	3·43	4·57	5·72	6·86	8·00	9·15	10·29	11·43	0·50	0·12	0·25	0·37
30	1·15	2·31	3·46	4·62	5·77	6·93	8·08	9·24	10·39	11·55	0·52	0·13	0·26	0·39
31	1·17	2·33	3·50	4·67	5·83	7·00	8·17	9·33	10·50	11·67	0·54	0·13	0·27	0·40
32	1·18	2·36	3·54	4·72	5·90	7·08	8·25	9·43	10·61	11·79	0·56	0·13	0·28	0·41
33	1·19	2·38	3·58	4·77	5·96	7·15	8·35	9·54	10·73	11·92	0·58	0·14	0·29	0·43
34	1·21	2·41	3·62	4·82	6·03	7·24	8·44	9·65	10·86	12·06	0·60	0·15	0·30	0·45
35	1·22	2·44	3·66	4·88	6·10	7·32	8·54	9·76	10·99	12·21	0·62	0·15	0·31	0·46
36	1·24	2·47	3·71	4·94	6·18	7·42	8·65	9·89	11·12	12·36	0·64	0·16	0·32	0·48
37	1·25	2·50	3·76	5·01	6·26	7·51	8·76	10·02	11·27	12·52	0·66	0·16	0·33	0·49
38	1·27	2·54	3·81	5·08	6·35	7·61	8·88	10·15	11·42	12·69	0·68	0·17	0·34	0·51
39	1·29	2·57	3·86	5·15	6·43	7·72	9·01	10·29	11·58	12·87	0·70	0·17	0·35	0·52
40	1·31	2·61	3·92	5·22	6·53	7·83	9·14	10·44	11·75	13·05	0·72	0·18	0·36	0·54
41	1·33	2·65	3·98	5·30	6·63	7·95	9·28	10·60	11·93	13·25	0·74	0·18	0·37	0·55
42	1·35	2·69	4·04	5·38	6·73	8·07	9·42	10·77	12·11	13·46	0·76	0·19	0·38	0·57
43	1·37	2·73	4·10	5·47	6·84	8·20	9·57	10·94	12·31	13·67	0·78	0·19	0·39	0·58
44	1·39	2·78	4·17	5·56	6·95	8·34	9·73	11·12	12·51	13·90	0·80	0·20	0·40	0·60
45	1·41	2·83	4·24	5·66	7·07	8·49	9·90	11·31	12·73	14·14	0·82	0·20	0·41	0·61
46	1·44	2·88	4·32	5·76	7·20	8·64	10·08	11·52	12·96	14·40	0·84	0·21	0·42	0·63
47	1·47	2·93	4·40	5·87	7·33	8·80	10·26	11·73	13·20	14·66	0·86	0·21	0·43	0·64
48	1·49	2·99	4·48	5·98	7·47	8·97	10·46	11·96	13·45	14·94	0·88	0·22	0·44	0·66
49	1·52	3·05	4·57	6·10	7·62	9·15	10·67	12·19	13·72	15·24	0·90	0·22	0·45	0·67
50	1·56	3·11	4·67	6·22	7·78	9·33	10·89	12·45	14·00	15·56	0·92	0·23	0·46	0·69
51	1·59	3·18	4·77	6·36	7·95	9·53	11·12	12·71	14·30	15·89	0·94	0·23	0·47	0·70
52	1·62	3·25	4·87	6·50	8·12	9·75	11·37	12·99	14·62	16·24	0·96	0·24	0·48	0·72
53	1·66	3·32	4·98	6·65	8·31	9·97	11·63	13·29	14·95	16·62	0·98	0·24	0·49	0·73
54	1·70	3·40	5·10	6·81	8·51	10·21	11·91	13·61	15·31	17·01	1·00	0·25	0·50	0·75
55	1·74	3·49	5·23	6·97	8·72	10·46	12·20	13·95	15·69	17·43	1·02	0·25	0·51	0·76
56	1·79	3·58	5·36	7·15	8·94	10·73	12·52	14·31	16·09	17·88	1·04	0·26	0·52	0·78
57	1·84	3·67	5·51	7·34	9·18	11·02	12·85	14·67	16·52	18·36	1·06	0·26	0·53	0·79
58	1·89	3·77	5·66	7·55	9·44	11·32	13·21	15·10	16·98	18·87	1·08	0·27	0·54	0·81
59	1·94	3·88	5·82	7·77	9·71	11·65	13·59	15·53	17·47	19·42	1·10	0·27	0·55	0·82
60	2·00	4·00	6·00	8·00	10·00	12·00	14·00	16·00	18·00	20·00	1·12	0·28	0·56	0·84
61	2·06	4·13	6·19	8·25	10·31	12·38	14·44	16·50	18·56	20·63	1·14	0·28	0·57	0·85
62	2·13	4·26	6·39	8·52	10·65	12·78	14·91	17·04	19·17	21·30	1·16	0·29	0·58	0·87
63	2·20	4·41	6·61	8·81	11·01	13·22	15·42	17·62	19·82	22·03	1·18	0·29	0·59	0·88
64	2·28	4·56	6·84	9·12	11·41	13·69	15·97	18·25	20·53	22·81	1·20	0·30	0·60	0·90
65	2·37	4·73	7·10	9·46	11·83	14·20	16·56	18·93	21·30	23·66	1·22	0·30	0·61	0·91
66	2·46	4·92	7·38	9·83	12·29	14·75	17·21	19·67	22·13	24·59	1·24	0·31	0·62	0·93
67	2·56	5·12	7·68	10·24	12·80	15·36	17·92	20·47	23·03	25·59	1·26	0·31	0·63	0·94
68	2·67	5·34	8·01	10·68	13·35	16·02	18·69	21·36	24·03	26·69	1·28	0·32	0·64	0·96
69	2·79	5·58	8·37	11·16	13·95	16·74	19·53	22·32	25·11	27·90	1·30	0·32	0·65	0·97

DIFFERENCE OF LONGITUDE AND CORRESPONDING DEPARTURE

Lat.	Difference of Longitude										Parts			
	1	2	3	4	5	6	7	8	9	10	D to 1°	15′	30′	45′
0°	1·00	2·00	3·00	4·00	5·00	6·00	7·00	8·00	9·00	10·00	0·01	0·00	0·00	0·01
4	1·00	2·00	2·99	3·99	4·99	5·99	6·98	7·98	8·98	9·98	0·02	0·00	0·01	0·02
6	0·99	1·99	2·98	3·98	4·97	5·97	6·96	7·96	8·95	9·95	0·03	0·01	0·02	0·02
8	0·99	1·98	2·97	3·96	4·95	5·94	6·93	7·92	8·91	9·90	0·04	0·01	0·02	0·03
10	0·98	1·97	2·95	3·94	4·92	5·91	6·89	7·88	8·86	9·85	0·05	0·01	0·03	0·04
12	0·98	1·96	2·93	3·91	4·89	5·87	6·85	7·83	8·80	9·78	0·06	0·02	0·03	0·05
14	0·97	1·94	2·91	3·88	4·85	5·82	6·79	7·76	8·73	9·70	0·07	0·02	0·04	0·05
15	0·97	1·93	2·90	3·86	4·83	5·80	6·76	7·73	8·69	9·66	0·08	0·02	0·04	0·06
16	0·96	1·92	2·88	3·85	4·81	5·77	6·73	7·69	8·65	9·61	0·09	0·02	0·05	0·07
17	0·96	1·91	2·87	3·83	4·78	5·74	6·69	7·65	8·61	9·56	0·10	0·03	0·05	0·08
18	0·95	1·90	2·85	3·80	4·76	5·71	6·66	7·61	8·56	9·51	0·11	0·03	0·06	0·08
19	0·95	1·89	2·84	3·78	4·73	5·67	6·62	7·56	8·51	9·46	0·12	0·03	0·06	0·09
20	0·94	1·88	2·82	3·76	4·70	5·64	6·58	7·52	8·46	9·40	0·13	0·03	0·07	0·10
21	0·93	1·87	2·80	3·73	4·67	5·60	6·54	7·47	8·40	9·34	0·14	0·04	0·07	0·11
22	0·93	1·85	2·78	3·71	4·64	5·56	6·49	7·42	8·34	9·27	0·15	0·04	0·08	0·11
23	0·92	1·84	2·76	3·68	4·60	5·52	6·44	7·36	8·28	9·21	0·16	0·04	0·08	0·12
24	0·91	1·83	2·74	3·65	4·57	5·48	6·39	7·31	8·22	9·14	0·17	0·04	0·09	0·13
25	0·91	1·81	2·72	3·63	4·53	5·44	6·34	7·25	8·16	9·06				
26	0·90	1·80	2·70	3·60	4·49	5·39	6·29	7·19	8·09	8·99				
27	0·89	1·78	2·67	3·56	4·46	5·35	6·24	7·13	8·02	8·91				
28	0·88	1·77	2·65	3·53	4·4[illegible]	5·30	6·18	7·06	7·95	8·83				
29	0·87	1·75	2·62	3·50	4·37	5·25	6·12	7·00	7·87	8·75				
30	0·87	1·73	2·60	3·46	4·33	5·20	6·06	6·93	7·79	8·66				
31	0·86	1·71	2·57	3·43	4·29	5·14	6·00	6·86	7·71	8·57				
32	0·85	1·70	2·54	3·39	4·24	5·09	5·94	6·78	7·63	8·48				
33	0·84	1·68	2·52	3·35	4·19	5·03	5·87	6·71	7·55	8·39				
34	0·83	1·66	2·49	3·32	4·15	4·97	5·80	6·63	7·46	8·29				
35	0·82	1·64	2·46	3·28	4·10	4·91	5·73	6·55	7·37	8·19				
36	0·81	1·62	2·43	3·24	4·05	4·85	5·66	6·47	7·28	8·09				
37	0·80	1·60	2·40	3·19	3·99	4·79	5·59	6·39	7·19	7·99				
38	0·79	1·58	2·36	3·15	3·94	4·73	5·52	6·30	7·09	7·88				
39	0·78	1·55	2·33	3·11	3·89	4·66	5·44	6·22	6·99	7·77				
40	0·77	1·53	2·30	3·06	3·83	4·60	5·36	6·13	6·89	7·66				
41	0·75	1·51	2·26	3·02	3·77	4·53	5·28	6·04	6·79	7·55				
42	0·74	1·49	2·23	2·97	3·72	4·46	5·20	5·95	6·69	7·43				
43	0·73	1·46	2·19	2·93	3·66	4·39	5·12	5·85	6·58	7·31				
44	0·72	1·44	2·16	2·88	3·60	4·32	5·04	5·75	6·47	7·19				
45	0·71	1·41	2·12	2·83	3·54	4·24	4·95	5·66	6·36	7·07				
46	0·69	1·39	2·08	2·78	3·47	4·17	4·86	5·56	6·25	6·95				
47	0·68	1·36	2·04	2·73	3·41	4·09	4·77	5·46	6·14	6·82				
48	0·67	1·34	2·01	2·68	3·35	4·01	4·68	5·35	6·02	6·69				
49	0·66	1·31	1·57	2·62	3·28	3·94	4·59	5·25	5·90	6·56				
50	0·64	1·29	1·93	2·57	3·21	3·86	4·50	5·14	5·79	6·43				
51	0·63	1·26	1·89	2·52	3·15	3·78	4·41	5·03	5·66	6·29				
52	0·62	1·23	1·85	2·46	3·08	3·69	4·31	4·93	5·54	6·16				
53	0·60	1·20	1·81	2·41	3·01	3·61	4·21	4·81	5·42	6·02				
54	0·59	1·18	1·76	2·35	2·94	3·53	4·11	4·[illegible]0	5·29	5·88				
55	0·57	1·16	1·72	2·29	2·87	3·44	4·02	4·59	5·16	5·74				
56	0·56	1·12	1·68	2·24	2·80	3·35	3·91	4·47	5·03	5·59				
57	0·54	1·09	1·63	2·18	2·72	3·27	3·81	4·36	4·90	5·45				
58	0·53	1·06	1·59	2·12	2·65	3·18	3·71	4·24	4·77	5·30				
59	0·52	1·03	1·55	2·06	2·58	3·09	3·61	4·12	4·64	5·16				
60	0·50	1·00	1·50	2·00	2·50	3·00	3·50	4·00	4·50	5·00				
61	0·48	0·97	1·45	1·94	2·42	2·91	3·39	3·88	4·36	4·85				
62	0·47	0·94	1·41	1·88	2·35	2·82	3·29	3·76	4·23	4·69				
63	0·45	0·91	1·36	1·82	2·27	2·72	3·18	3·63	4·09	4·54				
64	0·44	0·88	1·32	1·75	2·19	2·63	3·07	3·51	3·95	4·38				
65	0·42	0·85	1·27	1·69	2·11	2·54	2·96	3·38	3·80	4·23				
66	0·41	0·81	1·22	1·63	2·03	2·44	2·85	3·25	3·66	4·07				
67	0·39	0·78	1·17	1·56	1·95	2·34	2·74	3·13	3·52	3·91				
68	0·37	0·75	1·12	1·50	1·87	2·25	2·62	3·00	3·37	3·75				
69	0·36	0·72	1·08	1·43	1·79	2·15	2·51	2·87	3·23	3·58				

SPHERICAL TRAVERSE TABLE

	0°		1°		2°		3°		4°		5°		6°	
°	M	N	M	N	M	N	M	N	M	N	M	N	M	N
0	100.0	0												
1	100.0	0	100.0	0.0										
2	100.1	0	100.1	0.1	100.1	0.1								
3	100.1	0	100.1	0.1	100.2	0.2	100.3	0.3						
4	100.2	0	100.3	0.1	100.3	0.2	100.4	0.4	100.5	0.5				
5	100.4	0	100.4	0.1	100.4	0.3	100.5	0.5	100.6	0.6	100.8	0.8		
6	100.5	0	100.6	0.2	100.6	0.4	100.7	0.5	100.8	0.7	100.9	0.9	101.1	1.1
7	100.7	0	100.8	0.2	100.8	0.4	100.9	0.6	101.0	0.9	101.1	1.1	101.3	1.3
8	101.0	0	101.0	0.2	101.0	0.5	101.1	0.7	101.2	1.0	101.4	1.2	101.5	1.5
9	101.2	0	101.3	0.3	101.3	0.5	101.4	0.8	101.5	1.1	101.6	1.4	101.8	1.7
10	101.5	0	101.6	0.3	101.6	0.6	101.7	0.9	101.8	1.2	101.9	1.5	102.1	1.8
11	101.9	0	101.9	0.3	101.9	0.7	102.0	1.0	102.1	1.4	102.3	1.7	102.4	2.0
12	102.2	0	102.2	0.4	102.3	0.7	102.4	1.1	102.5	1.5	102.6	1.9	102.8	2.2
13	102.6	0	102.6	0.4	102.7	0.8	102.8	1.2	102.9	1.6	103.3	2.0	103.2	2.4
14	103.1	0	103.1	0.4	103.1	0.9	103.2	1.3	103.3	1.7	103.5	2.2	103.6	2.6
15	103.5	0	103.5	0.5	103.6	0.9	103.7	1.4	103.8	1.9	103.9	2.3	104.1	2.8
16	104.0	0	104.0	0.5	104.1	1.0	104.2	1.5	104.3	2.0	104.4	2.5	104.6	3.0
17	104.6	0	104.6	0.5	104.6	1.1	104.7	1.6	104.8	2.1	104.7	2.7	105.1	3.2
18	105.1	0	105.2	0.6	105.2	1.1	105.3	1.7	105.4	2.3	105.5	2.8	105.7	3.4
19	105.8	0	105.8	0.6	105.8	1.2	105.9	1.8	106.0	2.4	106.2	3.0	106.3	3.6
20	106.4	0	106.4	0.6	106.5	1.3	106.6	1.9	106.7	2.5	106.8	3.2	107.0	3.8
21	107.1	0	107.1	0.7	107.2	1.3	107.3	2.0	107.4	2.7	107.5	3.4	107.7	4.0
22	107.8	0	107.9	0.7	107.9	1.4	108.0	2.1	108.1	2.8	108.3	3.5	108.4	4.2
23	108.6	0	108.6	0.7	108.7	1.5	108.8	2.2	108.9	3.0	109.0	3.7	109.2	4.5
24	109.5	0	109.5	0.8	109.5	1.5	109.6	2.3	109.7	3.1	109.9	3.9	110.1	4.7
25	110.3	0	110.4	0.8	110.1	1.6	110.5	2.4	110.6	3.3	110.8	4.1	110.9	4.9
26	111.3	0	111.3	0.8	111.3	1.7	111.4	2.6	111.5	3.4	111.7	4.3	111.9	5.1
27	112.2	0	112.2	0.9	112.3	1.8	112.4	2.7	112.5	3.5	112.7	4.5	112.8	5.3
28	113.3	0	113.3	0.9	113.3	1.9	113.4	2.8	113.5	3.7	113.7	4.7	113.9	5.6
29	114.3	0	114.4	1.0	114.4	1.9	114.5	2.9	114.6	3.9	114.8	4.8	115.0	5.8
30	115.5	0	115.5	1.0	115.4	2.0	115.6	3.0	115.7	4.0	115.9	5.0	116.1	6.1
31	116.7	0	116.7	1.0	116.7	2.1	116.8	3.1	116.9	4.2	117.1	5.3	117.3	6.3
32	117.9	0	117.9	1.1	118.0	2.2	118.1	3.3	118.2	4.4	118.4	5.5	118.6	6.6
33	119.2	0	119.3	1.1	119.3	2.3	119.4	3.4	119.5	4.5	119.7	5.7	119.9	6.8
34	120.6	0	120.6	1.2	120.7	2.4	120.8	3.5	120.9	4.7	121.1	5.9	121.3	7.1
35	122.1	0	122.1	1.2	122.1	2.4	122.2	3.7	122.4	4.9	122.5	6.2	122.7	7.4
36	123.6	0	123.6	1.3	123.7	2.5	123.8	3.8	123.9	5.1	124.1	6.4	124.3	7.6
37	125.2	0	125.2	1.3	125.3	2.6	125.4	3.9	125.5	5.3	125.7	6.6	125.9	7.9
38	126.9	0	126.9	1.4	127.0	2.7	127.1	4.1	127.2	5.5	127.4	6.8	127.6	8.2
39	128.7	0	128.7	1.4	128.8	2.8	128.9	4.2	129.0	5.7	129.2	7.1	129.4	8.5
40	130.5	0	130.6	1.5	130.6	2.9	130.7	4.4	130.9	5.9	131.0	7.3	131.3	8.8
41	132.5	0	132.5	1.5	132.6	3.0	132.7	4.6	132.8	6.1	133.0	7.6	133.2	9.1
42	134.6	0	134.6	1.6	134.6	3.1	134.7	4.7	134.9	6.3	135.1	7.9	135.3	9.5
43	136.7	0	136.8	1.6	136.8	3.3	136.9	4.9	137.1	6.5	137.3	8.2	137.5	9.8
44	139.0	0	139.0	1.7	139.1	3.4	139.2	5.1	139.4	6.7	139.5	8.4	139.8	10.1
45	141.4	0	141.4	1.7	141.5	3.5	141.6	5.2	141.8	7.0	142.0	8.7	142.2	10.5
46	144.0	0	144.0	1.8	144.0	3.6	144.2	5.4	144.3	7.2	144.5	9.1	144.7	10.9
47	146.6	0	146.6	1.9	146.7	3.7	146.8	5.6	147.0	7.5	147.2	9.4	147.4	11.3
48	149.4	0	149.5	1.9	149.5	3.9	149.7	5.8	149.8	7.8	150.0	9.7	150.3	11.7
49	152.4	0	152.4	2.0	152.5	4.0	152.6	6.0	152.1	8.0	153.0	10.1	153.3	12.1
50	155.6	0	155.6	2.1	155.7	4.2	155.8	6.2	155.7	8.3	156.2	10.4	156.4	12.5
51	158.9	0	158.9	2.2	159.0	4.3	159.1	6.5	159.3	8.6	159.5	10.8	159.8	13.0
52	162.4	0	162.5	2.2	162.5	4.5	162.6	6.7	162.8	8.9	163.0	11.2	163.3	13.4
53	166.2	0	166.2	2.3	166.3	4.6	166.4	6.9	166.6	9.3	166.8	11.6	167.1	13.9
54	170.1	0	170.2	2.4	170.2	4.8	170.4	7.2	170.5	9.6	170.8	12.0	171.1	14.5
55	174.3	0	174.4	2.5	174.4	5.0	174.6	7.5	174.8	10.0	175.0	12.5	175.2	15.0
56	178.8	0	178.9	2.6	178.9	5.2	179.5	7.8	179.3	10.4	179.5	13.0	179.8	15.6
57	183.6	0	183.6	2.7	183.7	5.4	183.9	8.1	184.1	10.8	184.3	13.5	184.6	16.2
58	188.7	0	188.7	2.8	188.2	5.6	189.0	8.4	189.2	11.2	189.4	14.0	189.7	16.8
59	194.2	0	194.2	2.9	194.3	5.8	194.4	8.7	194.6	11.6	194.9	14.6	195.2	17.5
60	200.0	0	200.0	3.0	200.1	6.0	200.3	9.1	200.5	12.1	200.8	15.1	201.1	18.2

SPHERICAL TRAVERSE TABLE

°	0°		1°		2°		3°		4°		5°		6°	
°	M	N	M	N	M	N	M	N	M	N	M	N	M	N
61	206·3	0	206·3	3·1	206·4	6·3	206·5	9·4	206·8	12·6	207·1	15·8	207·4	19·0
62	213·0	0	213·0	3·3	213·2	6·6	213·3	9·9	213·5	13·1	213·8	16·4	214·2	19·8
63	220·3	0	220·3	3·4	220·4	6·8	220·6	10·3	220·8	13·7	221·1	17·2	221·5	20·6
64	228·1	0	228·2	3·6	228·3	7·2	228·4	10·7	228·7	14·3	229·0	17·9	229·4	21·5
65	236·6	0	236·7	3·7	236·8	7·5	236·9	11·2	237·2	15·0	237·5	18·8	237·9	22·5
66	245·8	0	245·9	3·9	246·0	7·8	246·2	11·8	246·5	15·7	246·8	19·6	247·2	23·6
67	255·9	0	256·0	4·1	256·1	8·2	256·2	12·3	256·6	16·5	256·9	20·6	257·3	24·8
68	266·9	0	267·0	4·3	267·1	8·6	267·3	13·0	267·6	17·3	268·0	21·7	268·4	26·0
69	279·0	0	279·1	4·5	279·2	9·1	279·4	13·6	279·7	18·2	280·1	22·8	280·6	27·4
70	292·4	0	292·4	4·8	292·6	9·6	292·8	14·4	293·1	19·2	293·5	24·0	294·0	28·9
71	307·2	0	307·2	5·1	307·3	10·1	307·6	15·2	307·9	20·3	308·3	25·4	308·9	30·5
72	323·6	0	323·7	5·4	323·8	10·7	324·1	16·1	324·4	21·5	324·8	26·9	325·4	32·3
73	342·0	0	342·1	5·7	342·2	11·4	342·4	17·1	342·9	22·9	343·3	28·6	343·9	34·4
74	362·8	0	362·9	6·1	363·0	12·2	363·3	18·3	363·7	24·4	364·2	30·5	364·8	36·6
75	386·4	0	386·4	6·5	386·6	13·0	386·9	19·6	387·3	26·1	387·8	32·6	388·5	39·2
76	413·3	0	404·0	7·0	413·6	14·0	413·9	21·0	414·4	28·0	414·9	35·1	415·6	42·2
77	444·5	0	444·6	7·6	444·8	15·1	445·2	22·7	445·6	30·3	446·1	37·9	447·0	43·5
78	481·0	0	481·0	8·2	481·3	16·4	481·6	24·6	482·1	32·9	482·8	41·2	483·6	49·4
79	524·1	0	524·2	9·0	524·4	18·0	524·8	27·0	525·4	36·0	526·1	45·0	527·0	54·1
80	575·9	0	576·0	9·9	576·2	19·8	576·7	29·7	577·3	39·7	578·2	49·6	579·1	59·6

°	7°		8°		9°		10°		11°		12°		13°	
°	M	N	M	N	M	N	M	N	M	N	M	N	M	N
7	101·5	1·5												
8	101·7	1·7	102·0	2·0										
9	102·0	1·9	102·2	2·2	102·5	2·5								
10	102·3	2·2	102·5	2·5	102·8	2·8	103·1	3·1						
11	102·6	2·4	102·9	2·7	103·1	3·1	103·4	3·4	103·8	3·8				
12	103·0	2·6	103·2	3·0	103·5	3·4	103·8	3·7	104·1	4·1	104·5	4·5		
13	103·4	2·8	103·6	3·2	103·9	3·7	104·2	4·1	104·5	4·5	104·9	4·9	105·3	5·3
14	103·8	3·1	104·1	3·5	104·3	3·9	104·6	4·4	105·0	4·8	105·4	5·3	105·8	5·8
15	104·3	3·3	104·5	3·8	104·8	4·2	105·1	4·7	105·5	5·2	105·8	5·7	106·2	6·2
16	104·8	3·5	105·0	4·0	105·3	4·5	105·6	5·1	106·0	5·6	106·4	6·1	106·8	6·6
17	105·3	3·7	105·6	4·3	105·9	4·8	106·2	5·4	106·5	5·9	106·9	6·5	107·3	7·1
18	106·0	4·0	106·2	4·6	106·5	5·1	106·8	5·7	107·1	6·3	107·5	6·9	107·9	7·5
19	106·6	4·2	106·8	4·8	107·1	5·5	107·4	6·1	107·7	6·7	108·1	7·3	108·5	7·9
20	107·2	4·5	107·5	5·1	107·7	5·8	108·1	6·4	108·4	7·1	108·8	7·7	109·2	8·4
21	107·9	4·7	108·2	5·4	108·4	6·1	108·8	6·8	109·1	7·5	109·5	8·2	109·9	8·9
22	108·7	5·0	108·9	5·7	109·2	6·4	109·5	7·1	109·9	7·8	110·3	8·6	110·7	9·3
23	109·4	5·2	109·7	6·0	110·0	6·7	110·3	7·5	110·7	8·3	111·1	9·0	111·5	9·8
24	110·3	5·5	110·5	6·3	110·8	7·0	111·0	7·9	111·5	8·7	111·9	9·5	112·3	10·3
25	111·2	5·7	111·4	6·6	111·7	7·4	111·9	8·2	112·4	9·1	112·8	9·9	113·2	10·8
26	112·1	6·0	112·4	6·8	112·6	7·7	112·9	8·6	113·4	9·5	113·7	10·4	114·2	11·3
27	113·1	6·3	113·3	7·2	113·6	8·1	114·0	9·0	114·3	9·9	114·7	10·8	115·2	11·8
28	114·1	6·5	114·4	7·5	114·7	8·4	115·1	9·4	115·4	10·3	115·8	11·3	116·2	12·3
29	115·2	6·8	115·5	7·8	115·8	8·8	116·1	9·8	116·5	10·8	116·9	11·8	117·3	12·8
30	116·3	7·1	116·6	8·1	116·9	9·1	117·2	10·2	117·6	11·2	118·0	12·3	118·5	13·3
31	117·5	7·4	117·8	8·4	118·1	9·5	118·5	10·6	118·8	11·7	119·3	12·8	119·7	13·9
32	118·6	7·7	119·1	8·8	119·4	9·9	119·8	11·0	120·1	12·1	120·6	13·3	121·0	14·4
33	120·1	8·0	120·4	9·1	120·7	10·3	121·1	11·4	121·5	12·6	121·9	13·8	122·7	15·0
34	121·5	8·3	121·8	9·5	122·1	10·7	122·5	11·9	122·9	13·1	123·3	14·3	123·8	15·6
35	123·0	8·6	123·3	9·8	123·6	11·1	124·0	12·3	124·4	13·6	124·8	14·9	125·3	16·2
36	124·5	8·9	124·8	10·2	125·1	11·5	125·5	12·8	125·9	14·1	126·4	15·4	126·9	16·7
37	126·2	9·3	126·4	10·6	126·8	11·9	127·1	13·3	127·6	14·6	128·0	16·0	128·5	17·4
38	127·9	9·6	128·1	11·0	128·5	12·4	128·9	13·8	129·3	15·2	129·7	16·6	130·2	18·0
39	129·6	9·9	129·9	11·4	130·3	12·8	130·7	14·3	131·1	15·7	131·5	17·2	132·1	18·7
40	131·5	10·3	131·8	11·8	132·2	13·3	132·6	14·8	133·0	16·3	133·5	17·8	134·0	19·4
41	133·5	10·7	133·8	12·2	134·1	13·8	134·5	15·3	135·0	16·9	135·5	18·5	136·0	20·1
42	135·6	11·1	135·9	12·6	136·2	14·3	136·6	15·9	137·1	17·5	137·6	19·1	138·1	20·8
43	137·8	11·4	138·1	13·1	138·4	14·8	138·8	16·4	139·3	18·1	139·8	19·8	140·3	21·5

SPHERICAL TRAVERSE TABLE

°	7° M	7° N	8° M	8° N	9° M	9° N	10° M	10° N	11° M	11° N	12° M	12° N	13° M	13° N
44	140·1	11·9	140·4	13·6	140·7	15·4	141·2	17·0	141·6	18·8	142·1	20·5	142·7	22·3
45	142·5	12·3	142·8	14·0	143·2	15·8	143·6	17·6	144·1	19·4	144·6	21·3	145·1	23·1
46	145·0	12·7	145·4	14·5	145·7	16·4	146·2	18·3	146·6	20·1	147·2	22·0	147·7	23·9
47	147·7	13·2	148·1	15·1	148·5	17·0	148·9	18·9	149·4	20·8	149·9	22·8	150·8	24·8
48	150·6	13·6	150·9	15·6	151·3	17·6	151·7	19·6	152·2	21·6	152·8	23·6	153·4	25·6
49	153·6	14·1	153·9	16·2	154·3	18·2	154·8	20·3	155·3	22·4	155·9	24·4	156·4	26·6
50	156·7	14·6	157·1	16·7	157·5	18·9	158·0	21·0	158·5	23·2	159·0	25·3	159·7	27·5
51	160·1	15·2	160·5	17·4	160·9	19·6	161·4	21·8	161·9	24·0	162·5	26·2	163·1	28·5
52	163·6	15·7	164·0	18·0	164·4	20·3	165·0	22·6	165·5	24·9	166·1	27·2	166·7	29·5
53	167·4	16·3	167·8	18·6	168·2	21·0	168·7	23·4	169·3	25·8	169·9	28·2	170·5	30·6
54	171·4	16·9	171·8	19·3	172·2	21·8	172·8	24·3	173·3	26·8	173·9	29·3	174·6	31·8
55	175·7	17·5	176·1	20·1	176·5	22·6	177·0	25·2	177·6	27·8	178·2	30·4	178·9	33·0
56	180·2	18·2	180·6	20·8	181·1	23·5	181·6	26·1	182·2	28·8	182·8	31·5	183·5	34·2
57	185·0	18·9	185·4	21·6	185·9	24·4	186·4	27·1	187·0	29·9	187·7	32·7	188·4	35·5
58	190·1	19·6	190·6	22·5	191·1	25·3	191·6	28·2	189·2	31·1	192·9	34·0	193·6	36·9
59	195·6	20·4	196·1	23·4	196·6	26·4	197·2	29·3	197·8	32·3	198·5	35·4	199·3	38·4
60	201·5	21·3	202·0	24·3	202·5	27·4	203·1	30·5	203·7	33·7	204·5	36·8	205·3	40·0
61	207·8	22·1	208·3	25·3	208·8	28·6	209·9	31·8	210·1	35·1	210·9	38·3	211·7	41·6
62	214·6	23·1	215·1	26·4	215·7	29·8	216·3	33·2	217·0	36·6	217·8	40·0	218·6	43·4
63	221·9	24·1	222·4	27·6	223·0	31·1	223·7	34·6	224·4	38·1	225·2	41·7	226·1	45·3
64	229·8	25·2	230·4	28·8	231·0	32·5	231·6	36·1	232·4	39·8	233·2	43·6	234·1	47·3
65	238·4	26·3	238·9	30·1	239·6	34·0	240·3	37·8	241·0	41·7	241·9	45·6	242·8	49·5
66	247·7	27·6	248·4	31·6	248·9	35·6	249·7	39·6	250·5	43·7	251·4	47·7	252·3	51·8
67	257·9	28·9	258·4	33·1	259·1	37·3	259·9	41·5	260·7	45·8	261·6	50·1	262·7	54·4
68	269·0	30·4	269·6	34·8	270·3	39·2	271·1	43·6	271·9	48·1	272·9	52·6	274·0	57·1
69	281·1	32·0	281·8	36·6	282·5	41·3	283·4	45·9	284·3	50·6	285·3	55·4	286·4	60·1
70	294·6	33·7	295·3	38·6	296·0	43·5	296·9	48·4	297·9	53·4	298·9	58·4	300·1	63·4
71	309·5	35·7	310·2	40·8	311·0	46·0	311·9	51·2	312·9	56·4	314·0	61·7	315·2	67·0
72	326·0	37·8	326·8	43·2	327·6	48·7	328·6	54·3	329·6	59·8	330·8	65·4	332·1	71·0
73	344·6	40·2	345·4	46·0	346·3	51·8	347·3	57·7	348·4	63·6	349·7	69·5	351·0	75·5
74	365·5	42·8	366·4	49·0	367·3	55·2	368·4	61·7	369·6	67·8	370·9	74·1	372·3	80·5
75	389·0	45·8	390·2	52·5	391·2	59·1	392·3	65·8	393·6	72·5	395·1	79·3	396·5	86·2
76	416·5	49·2	417·4	56·4	418·5	63·5	419·7	70·7	421·1	78·0	422·6	85·2	424·3	92·6
77	447·9	53·2	448·9	60·9	450·1	68·6	541·4	76·4	452·9	84·2	454·5	92·1	456·2	100·0
78	484·6	57·8	485·7	66·1	487·0	74·5	488·4	83·0	490·0	91·4	491·7	100·0	493·6	108·6
79	528·0	63·1	529·2	72·3	530·6	81·5	532·2	90·7	533·9	100·0	535·8	109·3	537·9	118·8
80	580·2	69·6	581·5	79·7	583·1	89·8	584·8	100·0	586·7	110·2	588·7	120·9	591·0	130·9

°	14° M	14° N	15° M	15° N	16° M	16° N	17° M	17° N	18° M	18° N	19° M	19° N	20° M	20° N
14	106·2	6·2												
15	106·7	6·7	107·2	7·2										
16	107·2	7·1	107·7	7·7	108·2	8·2								
17	107·8	7·6	108·3	8·2	108·8	8·8	109·3	9·3						
18	108·4	8·1	108·9	8·7	109·3	9·3	109·9	9·9	110·6	10·6				
19	109·0	8·6	109·5	9·2	110·0	9·9	110·6	10·5	111·2	11·2	111·9	11·9		
20	109·7	9·1	110·2	9·8	110·7	10·4	111·3	11·1	111·9	11·8	112·5	12·5	113·2	13·2
21	110·4	9·6	110·9	10·3	111·4	10·0	112·0	11·7	112·6	12·5	113·3	13·2	114·0	14·0
22	111·2	10·1	111·7	10·8	112·2	11·6	112·8	12·3	113·4	13·1	114·1	13·9	114·8	14·7
23	112·0	10·6	112·5	11·4	113·0	12·2	113·6	13·0	114·2	13·8	114·9	14 6	115·6	15·4
24	112·8	11·1	113·3	11·9	113·9	12·8	114·5	13·6	115·1	14·5	115·8	15·3	116·5	16·2
25	113·7	11·6	114·2	12·5	114·8	13·4	115·4	14·3	116·0	15·1	116·7	16·1	117·4	17·0
26	114·6	12·2	115·2	13·1	115·7	14·0	116·3	14·9	117·0	15·8	117·7	17·0	118·4	17·7
27	115·7	12·7	116·2	13·6	116·8	14·6	117·4	15·6	118·0	16·6	118·8	17·5	119·4	18·5
28	116·7	13·3	117·3	14·2	117·8	15·2	118·4	16·3	119·1	17·3	119·8	18·3	120·5	19·3
29	117·8	13·8	118·4	14·8	118·9	15·9	119·6	16·9	120·2	18·0	120·9	19·1	121·7	20·2
30	119·0	14·4	119·5	15·5	120·1	16·6	120·7	17·6	121·4	18·8	122·1	19·9	122·9	21·0
31	120·2	15·0	120·8	16·1	121·4	17·2	122·0	18·4	122·7	19·5	123·4	20·7	124·1	21·9
32	121·5	15·6	122·1	16·7	122·7	17·9	123·3	19·1	124·0	20·3	124·7	21·5	125·5	22·7

SPHERICAL TRAVERSE TABLE

	14°		15°		16°		17°		18°		19°		20°	
°	M	N	M	N	M	N	M	N	M	N	M	N	M	N
33	122·9	16·2	123·4	17·4	124·0	18·6	124·7	19·9	125·4	21·1	126·1	22·4	126·9	23·6
34	124·3	16·8	124·9	18·1	125·5	19·3	126·1	20·6	126·8	21·9	127·6	23·2	128·4	24·6
35	125·8	17·5	126·4	18·8	127·0	20·1	127·7	21·4	128·4	22·7	129·1	24·1	129·9	25·5
36	127·4	18·1	128·0	19·5	128·6	20·8	129·2	22·2	130·0	23·6	130·7	25·0	131·5	26·4
37	129·0	18·8	129·6	20·2	130·3	21·6	130·9	23·0	131·7	24·5	132·4	25·9	133·2	27·4
38	130·8	19·5	131·4	20·9	132·0	22·4	132·7	23·9	133·4	25·4	134·2	26·9	135·0	28·4
39	132·6	20·2	133·2	21·7	133·9	23·2	134·6	24·8	135·3	26·3	136·1	27·9	136·9	29·5
40	134·5	20·9	135·1	22·5	135·8	24·1	136·5	25·6	137·3	27·3	138·1	28·9	138·9	30·5
41	136·5	21·7	137·2	23·3	137·8	24·9	138·6	26·6	139·3	28·2	140·1	29·9	141·0	31·6
42	138·7	22·4	139·3	24·1	140·0	25·8	140·7	27·5	141·5	29·3	142·3	31·0	143·2	32·8
43	140·9	23·2	141·6	25·0	142·2	26·7	143·0	28·5	143·8	30·3	144·6	32·1	145·5	33·9
44	143·3	24·1	143·9	25·9	144·6	27·7	145·4	29·5	146·2	31·4	147·0	33·2	147·9	35·1
45	145·7	24·9	146·4	26·8	147·1	28·7	147·9	30·6	148·7	32·5	149·6	34·4	150·5	36·4
46	148·4	25·8	149·0	27·7	149·8	29·7	150·5	31·7	151·4	33·6	152·2	35·7	153·2	37·7
47	151·1	26·7	151·8	28·7	152·5	30·7	153·3	32·8	154·2	34·8	155·1	36·9	156·0	39·0
48	154·0	27·7	154·7	29·8	155·5	31·8	156·3	34·0	157·1	36·1	158·1	38·2	159·0	40·4
49	157·1	28·7	157·8	30·8	158·6	33·0	159·4	35·2	160·3	37·4	161·2	39·6	162·2	41·9
50	160·3	29·7	161·1	31·9	161·8	34·2	162·7	36·4	163·6	38·7	164·5	41·1	165·6	43·4
51	163·8	30·8	164·5	33·1	165·3	35·4	166·2	37·8	167·1	40·1	168·1	42·5	169·1	44·9
52	167·4	31·9	168·2	34·3	169·0	36·7	169·8	39·1	170·8	41·6	171·8	44·1	172·8	46·6
53	171·2	33·1	172·0	35·6	172·9	38·0	173·8	40·6	174·7	43·1	175·7	45·7	176·8	48·3
54	175·3	34·3	176·1	36·9	177·0	39·5	177·9	42·1	178·9	44·7	179·9	47·4	181·0	50·1
55	179·7	35·6	180·5	38·3	181·4	40·9	182·3	43·7	183·3	46·4	184·4	49·2	185·5	52·0
56	184·3	37·0	185·1	39·7	186·0	42·5	187·0	45·3	188·0	48·2	189·1	51·0	190·3	54·0
57	189·2	38·4	190·1	41·3	191·0	44·2	192·0	47·1	193·1	50·0	194·2	53·0	195·4	56·0
58	194·5	39·9	195·3	42·9	196·3	45·9	197·3	48·9	198·4	52·0	199·6	55·1	200·8	58·2
59	200·1	41·5	201·0	44·6	202·0	47·7	203·0	50·9	204·2	54·1	205·3	57·3	206·6	60·6
60	206·1	43·2	207·1	46·4	208·1	49·7	209·1	53·0	210·3	56·3	211·5	59·6	212·8	63·0
61	212·6	45·0	213·5	48·3	214·6	51·7	215·7	55·2	216·9	58·6	218·2	62·1	219·5	65·7
62	219·5	46·9	220·5	50·4	221·6	53·9	222·7	57·5	224·0	61·1	225·3	64·8	226·7	68·4
63	227·0	48·9	228·0	52·6	229·1	56·3	230·3	60·0	231·6	63·8	233·0	67·6	234·4	71·4
64	235·1	51·1	236·2	54·9	237·3	58·8	238·5	62·7	239·9	66·6	241·3	70·6	242·8	74·6
65	243·9	53·5	245·0	57·5	246·2	61·5	247·4	65·6	248·8	69·7	250·3	73·8	251·8	78·1
66	253·4	56·0	254·5	60·2	255·8	64·4	257·1	68·7	258·5	73·0	260·0	77·3	261·6	81·7
67	263·8	58·7	265·0	63·2	266·2	67·5	267·6	72·0	269·1	76·5	270·7	81·1	272·4	85·7
68	275·1	61·7	276·4	66·3	277·7	71·0	279·1	75·7	280·7	80·4	282·3	85·2	284·1	90·1
69	287·6	64·9	288·9	69·8	290·3	74·7	291·8	79·6	293·4	84·6	295·1	89·7	296·9	94·8
70	301·3	68·5	302·7	73·6	304·2	78·8	305·7	84·0	307·4	89·3	309·2	94·6	311·1	100·0
71	316·6	72·4	318·0	77·8	319·5	83·3	321·2	88·8	323·0	94·4	324·9	100·0	326·9	105·7
72	335·5	76·7	335·0	82·5	336·7	88·3	338·4	94·1	340·3	100·0	342·3	106·0	344·4	112·0
73	352·5	81·5	354·1	87·6	355·8	93·8	357·7	100·0	359·6	106·3	361·7	112·6	364·0	119·0
74	373·9	86·9	375·6	93·4	377·4	100·0	379·4	106·6	381·5	113·3	383·7	120·1	386·1	126·9
75	398·2	93·0	400·0	100·0	401·9	107·0	404·0	114·1	406·3	121·3	408·6	128·5	411·2	135·8
76	426·0	100·0	427·9	107·5	430·0	115·1	432·2	122·6	434·6	130·3	437·2	138·1	439·9	146·0
77	458·2	108·0	460·2	116·1	462·5	124·2	464·8	132·4	467·4	140·7	471·2	149·1	473·1	157·7
78	495·7	117·3	497·9	127·6	500·4	134·9	502·8	143·8	505·7	152·9	508·7	162·0	511·8	171·2
79	540·1	118·3	542·6	137·8	548·2	147·5	548·0	157·3	551·1	167·2	554·3	177·1	557·7	187·2
80	593·5	141·1	596·2	152·0	599·1	162·6	602·2	173·4	605·5	184·3	609·1	195·3	612·8	206·4

	21°		22°		23°		24°		25°		26°		27°	
°	M	N	M	N	M	N	M	N	M	N	M	N	M	N
21	114·7	14·7												
22	115·5	15·5	116·3	16·3										
23	116·4	16·3	117·2	17·1	118·0	18·0								
24	117·2	17·1	118·1	18·0	118·9	18·9	119·8	19·8						
25	118·2	17·9	119·0	18·8	119·9	19·8	120·8	20·8	121·7	21·7				
26	119·2	18·7	120·0	19·7	120·9	20·7	121·8	21·7	122·8	22·8	123·8	23·8		
27	120·2	19·6	121·0	20·6	121·9	21·6	122·8	22·7	123·8	23·8	124·9	24·8	126·0	26·0
28	121·3	20·4	122·1	21·5	123·0	22·6	124·0	23·7	125·0	24·8	126·0	25·9	127·1	27·1

SPHERICAL TRAVERSE TABLE

°	21° M	21° N	22° M	22° N	23° M	23° N	24° M	24° N	25° M	25° N	26° M	26° N	27° M	27° N
29	122·5	21·3	123·3	22·4	124·2	23·5	125·2	24·7	126·2	25·8	127·2	27·0	128·3	28·2
30	123·2	22·2	124·5	23·3	125·4	24·5	126·4	25·7	127·4	26·9	128·2	28·2	129·6	29·4
31	125·0	23·1	125·8	24·3	126·7	25·5	127·7	26·7	128·7	28·0	129·8	29·3	130·9	30·6
32	126·3	24·0	127·2	25·2	128·1	26·5	129·1	27·8	130·1	29·1	131·2	30·5	132·3	31·8
33	127·7	24·9	128·6	26·2	129·5	27·6	130·5	28·9	131·6	30·3	132·7	31·7	133·8	33·1
34	129·2	25·9	130·1	27·2	131·0	28·6	132·0	30·0	133·1	31·4	134·2	32·9	135·4	34·4
35	130·8	26·9	131·7	28·3	132·6	29·7	133·6	31·2	134·7	32·6	135·8	34·1	137·0	35·7
36	132·4	27·9	133·3	29·4	134·3	30·8	135·3	32·3	136·4	33·9	137·5	35·4	138·7	37·0
37	134·1	28·9	135·0	30·4	136·0	32·0	137·1	33·5	138·2	35·1	139·3	36·7	140·5	38·4
38	135·9	30·0	136·9	31·6	137·9	33·2	138·9	34·8	140·0	36·4	141·2	38·1	142·4	39·8
39	137·8	31·1	138·8	32·7	139·5	34·4	140·9	36·0	142·0	37·8	143·2	39·5	144·4	41·2
40	139·8	32·2	140·8	33·9	141·8	35·6	142·9	37·4	144·0	39·1	145·2	40·9	146·5	42·8
41	141·9	33·4	142·9	35·1	143·9	36·9	145·0	38·7	146·2	40·5	147·4	42·4	148·7	44·3
42	144·1	34·6	145·1	36·4	146·2	38·2	147·3	40·1	148·5	42·0	149·7	43·9	151·0	45·9
43	146·5	35·8	147·5	37·7	148·5	39·6	149·7	41·5	150·9	43·5	152·1	45·5	153·5	47·5
44	148·9	37·1	149·9	39·0	151·0	41·0	152·2	43·0	153·4	45·0	154·7	47·1	156·0	49·2
45	151·5	38·4	152·5	40·4	153·6	42·4	154·8	44·5	156·0	46·6	157·3	48·8	158·7	50·4
46	154·2	39·7	155·3	41·8	156·4	44·0	157·6	46·1	158·8	48·3	160·2	50·5	161·6	52·8
47	157·1	41·2	158·1	43·3	159·3	45·5	160·5	47·8	161·8	50·0	163·1	52·3	164·6	54·6
48	160·1	42·6	161·2	44·9	162·3	47·1	163·6	49·4	164·9	51·8	166·3	54·2	167·7	56·6
49	163·3	44·2	164·4	46·5	165·6	48·8	166·8	51·2	168·2	53·6	169·6	56·1	171·1	58·6
50	166·6	45·7	167·8	48·1	169·0	50·6	170·3	53·1	171·6	55·6	173·1	58·1	174·6	60·7
51	170·2	47·4	171·4	49·9	172·7	52·4	173·9	55·0	175·3	57·6	176·8	60·2	178·3	62·9
52	174·0	49·1	175·2	51·7	176·4	54·3	177·8	57·0	179·2	59·7	180·7	62·4	182·3	65·2
53	178·0	50·9	179·2	53·6	180·5	56·3	181·9	59·1	183·3	61·9	184·9	64·7	186·5	67·6
54	182·2	52·8	183·5	55·6	184·8	58·4	186·2	61·3	187·7	64·2	189·3	67·1	190·9	70·1
55	186·7	54·8	188·0	57·7	189·4	60·6	190·8	63·6	192·4	66·6	194·0	69·7	195·7	72·8
56	191·6	56·9	192·9	59·9	194·3	62·9	195·7	66·0	197·3	69·1	199·0	72·3	200·7	75·5
57	196·7	59·1	198·0	62·2	199·5	65·4	201·0	68·6	202·6	71·8	204·3	75·1	206·1	78·5
58	202·1	61·4	203·5	64·7	205·0	67·9	206·6	71·2	208·2	74·6	210·0	78·0	211·8	81·5
59	208·0	63·9	209·4	67·2	210·9	70·6	212·5	74·1	214·2	77·6	216·0	81·2	217·9	84·8
60	214·2	66·5	215·7	70·0	217·3	73·5	218·9	77·1	220·7	80·8	222·5	84·5	224·5	88·2
61	220·9	69·2	222·5	72·9	224·1	76·6	225·8	80·3	227·6	84·1	229·5	88·0	231·5	97·9
62	228·2	72·2	229·7	76·0	231·4	79·8	233·2	83·7	235·0	87·7	237·0	91·7	239·1	95·8
63	235·9	75·3	237·6	79·3	239·3	83·3	241·1	87·4	243·0	91·5	245·1	95·7	247·2	100·0
64	244·3	78·7	246·0	82·8	247·8	87·0	249·7	91·3	251·7	95·6	253·8	100·0	256·0	104·5
65	253·5	82·3	255·2	86·6	257·1	91·0	259·0	95·5	261·1	100·0	263·3	104·6	265·6	109·3
66	263·4	86·2	265·2	90·7	267·1	95·3	269·1	100·0	271·3	104·7	273·5	109·5	275·9	114·4
67	274·1	90·4	276·0	95·2	278·0	100·0	280·1	104·9	282·4	109·9	284·7	114·9	287·2	120·0
68	285·9	95·0	287·9	100·0	290·0	105·1	292·2	110·2	294·5	115·4	297·0	120·7	299·6	126·1
69	298·9	100·0	301·0	105·3	303·1	110·6	305·4	116·0	307·9	121·5	310·5	127·1	313·2	132·7
70	313·2	105·5	315·3	111·0	317·6	116·6	320·1	122·3	322·6	128·1	325·3	134·0	328·1	140·0
71	329·0	111·5	331·3	117·3	333·7	123·3	336·2	129·3	338·9	135·4	341·7	141·6	344·7	148·0
72	346·6	118·1	349·0	124·3	351·6	130·6	354·2	137·0	357·1	143·5	360·0	150·1	363·2	156·8
73	366·4	125·6	368·9	132·1	371·6	138·8	374·4	145·6	377·4	152·5	380·5	159·5	383·9	166·7
74	388·6	133·9	391·3	140·9	394·1	148·0	397·1	155·3	400·3	162·6	403·6	170·1	407·2	177·7
75	413·9	143·3	416·7	150·8	419·7	158·4	422·9	166·5	426·3	174·0	429·9	182·0	432·6	190·2
76	442·8	154·0	445·8	162·0	449·0	170·3	452·5	178·6	456·1	187·0	459·9	195·6	463·9	204·4
77	476·2	166·3	479·4	175·0	482·9	183·9	486·6	192·8	490·5	202·0	494·6	211·3	498·9	220·7
78	515·2	180·6	518·7	190·9	522·5	199·7	526·5	209·5	530·7	219·4	535·1	229·5	539·8	239·7
79	561·4	197·5	565·3	207·8	569·3	218·4	573·7	229·1	578·3	239·9	583·1	250·9	588·2	262·1
80	616·9	217·7	621·1	229·1	625·6	240·7	630·4	252·5	635·4	264·5	610·7	276·6	646·3	289·0

°	28° M	28° N	29° M	29° N	30° M	30° N	31° M	31° N	32° M	32° N	33° M	33° N	34° M	34° N
28	128·3	28·3												
29	129·5	29·5	130·7	30·7										
30	130·8	30·7	132·0	32·0	133·3	33·3								
31	132·1	31·9	133·4	33·3	134·7	34·7	136·1	36·1						
32	133·5	33·2	134·8	34·6	136·2	36·1	137·6	37·5	139·0	39·0				
33	135·0	34·5	136·3	36·0	137·7	37·5	139·1	39·0	140·6	40·6	142·2	42·2		

SPHERICAL TRAVERSE TABLE

°	28° M	28° N	29° M	29° N	30° M	30° N	31° M	31° N	32° M	32° N	33° M	33° N	34° M	34° N
34	136·6	35·9	137·9	37·4	139·3	38·9	140·7	40·5	142·2	42·1	143·8	43·8	145·5	45·5
35	138·3	37·2	139·6	38·8	141·0	40·4	142·4	42·1	143·9	43·8	145·6	45·5	147·3	47·2
36	140·0	38·6	141·3	40·3	142·7	41·9	144·2	43·7	145·8	45·4	147·4	47·2	149·1	49·0
37	141·8	40·1	143·2	41·8	144·6	43·5	146·1	45·3	147·6	47·1	149·3	48·9	151·0	50·8
38	143·7	41·5	145·1	43·3	146·5	45·1	148·0	46·9	149·6	48·8	151·3	50·7	153·1	52·7
39	145·7	43·1	147·1	44·9	148·6	46·7	150·1	48·7	151·7	50·6	153·4	52·6	155·2	54·6
40	147·8	44·6	149·3	46·5	150·7	48·4	152·3	50·4	153·9	52·4	155·7	54·5	157·5	56·6
41	150·1	46·2	151·5	48·2	153·0	50·2	154·6	52·2	156·2	54·3	158·0	56·4	159·8	58·6
42	152·4	47·9	153·9	49·9	155·4	52·0	157·0	54·1	158·7	56·3	160·4	58·5	162·3	60·8
43	154·9	49·6	156·3	51·7	157·9	53·8	159·5	56·0	161·2	58·3	163·0	60·6	164·9	62·9
44	157·5	51·3	158·9	53·5	160·5	55·8	162·2	58·0	163·9	60·3	165·8	62·7	167·7	65·1
45	160·2	53·2	161·7	55·4	163·3	57·7	165·0	60·1	166·8	62·5	168·6	64·9	170·6	67·4
46	163·0	55·1	164·6	57·4	166·2	59·8	167·9	62·2	169·7	64·7	171·6	67·2	173·6	69·8
47	166·1	57·0	167·6	59·4	169·3	61·9	171·1	64·4	172·9	67·0	174·8	69·6	176·9	72·3
48	169·3	59·0	170·9	61·6	172·6	64·1	174·3	66·7	176·2	69·4	178·2	72·1	180·3	74·9
49	172·6	61·2	174·3	63·8	176·0	66·4	177·8	69·1	179·7	71·9	181·7	74·7	183·9	77·6
50	176·2	63·4	177·9	66·1	179·1	68·8	181·5	71·6	183·4	74·5	185·5	77·4	187·7	80·4
51	180·0	65·7	181·7	68·4	183·5	70·3	185·4	74·2	187·4	77·2	189·5	80·2	191·7	83·3
52	184·0	68·1	185·7	70·9	187·6	73·9	189·5	76·9	191·5	80·0	193·7	83·1	195·9	86·3
53	188·2	70·6	190·0	73·6	191·9	76·6	193·8	79·7	195·9	82·9	198·1	86·2	200·4	89·5
54	192·7	73·2	194·5	76·3	196·4	79·5	198·5	82·7	200·6	86·0	202·9	89·4	205·2	92·8
55	197·5	75·9	199·3	79·2	201·3	82·4	203·4	85·8	205·6	89·2	207·9	92·7	210·3	96·3
56	202·5	78·8	204·5	82·2	206·5	85·6	208·6	89·1	210·9	92·6	213·2	96·3	215·7	100·0
57	207·9	80·0	209·9	85·4	212·0	88·9	214·2	92·5	216·6	96·2	218·9	100·0	221·5	103·9
58	213·7	85·1	215·8	88·7	217·9	92·4	220·2	96·2	222·5	100·0	225·0	103·9	227·6	107·9
59	219·9	88·5	222·0	92·2	224·2	96·1	226·5	100·0	228·9	104·0	231·5	108·1	234·2	112·3
60	226·5	92·1	228·7	96·0	230·9	100·0	233·3	104·1	235·8	108·2	238·5	112·5	241·2	116·8
61	233·6	95·9	235·8	100·0	238·2	104·2	240·6	108·4	243·2	112·7	245·9	117·2	248·8	121·7
62	241·2	100·0	243·5	104·2	246·0	108·6	248·5	113·0	251·2	117·5	254·0	122·1	256·9	126·9
63	249·5	104·3	251·8	108·8	254·3	113·3	257·0	117·9	259·7	122·6	262·6	127·5	265·7	132·4
64	258·4	109·0	260·8	113·6	263·4	118·4	266·1	123·2	269·0	128·1	272·0	133·1	275·2	138·3
65	268·0	114·0	270·5	118·9	273·2	123·8	276·0	128·9	279·0	134·0	282·1	139·3	285·4	144·6
66	278·5	119·4	281·1	124·5	283·9	129·7	286·8	135·0	289·9	140·3	293·2	145·9	296·6	151·5
67	289·9	125·3	292·6	130·6	295·5	136·0	298·6	141·6	301·8	147·2	305·2	153·0	308·6	158·9
68	302·3	131·6	305·2	137·2	308·2	142·9	311·4	148·7	314·8	154·7	318·3	160·7	322·0	167·0
69	316·0	138·5	319·0	144·4	322·2	150·4	325·5	156·5	329·0	162·8	332·7	169·2	336·6	175·7
70	331·1	146·1	334·3	152·3	337·6	158·6	341·1	165·1	344·8	171·7	348·6	178·4	352·7	185·3
71	347·9	154·4	351·2	161·0	354·7	167·7	358·3	174·5	362·2	181·5	366·2	188·6	370·5	195·9
72	366·5	163·6	370·0	170·6	373·7	177·7	377·5	184·9	381·6	192·3	385·9	199·9	390·3	207·6
73	387·4	173·9	391·1	181·3	394·9	188·8	399·0	196·5	403·3	204·4	407·8	212·4	412·6	220·6
74	410·9	185·4	414·8	193·9	413·9	201·3	423·2	209·5	427·8	217·9	432·6	226·5	437·6	235·2
75	437·6	198·4	441·8	206·8	446·1	215·5	450·7	224·2	455·6	234·3	460·7	242·4	466·0	251·7
76	468·2	213·3	472·6	222·3	477·3	231·6	482·2	241·0	487·4	250·6	492·9	260·5	498·6	270·5
77	503·5	230·3	508·3	240·1	513·3	250·1	518·6	260·3	524·2	270·7	530·1	281·3	536·2	292·1
78	544·7	250·1	549·9	260·8	555·4	271·6	561·1	282·9	567·2	294·0	573·5	305·5	580·2	317·3
79	593·6	273·5	599·2	285·2	605·2	297·0	611·4	309·1	618·0	321·5	624·9	334·1	632·2	347·0
80	652·2	301·5	658·4	314·4	665·0	327·4	671·8	340·8	679·0	354·4	686·7	368·3	694·6	382·5

°	35° M	35° N	36° M	36° N	37° M	37° N	38° M	38° N	39° M	39° N	40° M	40° N	41° M	41° N
35	149·0	49·												
36	150·9	50·9	152·8	52·8										
37	152·9	52·8	154·8	54·7	156·8	56·8								
38	154·9	54·7	156·9	56·8	158·9	58·9	161·0	61·0						
39	157·1	56·7	159·0	58·8	161·1	61·0	163·3	63·3	165·6	65·6				
40	159·4	58·8	161·4	61·0	163·5	63·2	165·7	65·6	168·0	67·9	170·4	70·4		
41	161·8	60·9	163·8	63·2	166·0	65·5	168·1	67·9	170·5	70·4	173·0	72·9	175·6	75·6
42	164·3	63·0	166·3	65·4	168·2	67·8	170·8	70·3	173·1	72·9	175·7	75·5	178·4	78·3
43	166·9	65·3	169·0	67·7	171·2	70·3	173·5	72·9	175·9	75·5	178·5	78·2	181·2	81·1
44	169·7	67·6	171·8	70·2	174·1	72·8	176·4	75·4	178·9	78·2	181·5	81·0	184·2	83·9

SPHERICAL TRAVERSE TABLE

	35°		36°		37°		38°		39°		40°		41°	
°	M	N	M	N	M	N	M	N	M	N	M	N	M	N
45	172·6	70·0	174·8	72·7	177·1	75·4	179·5	78·1	182·0	81·0	184·6	83·9	187·4	86·9
46	176·7	72·5	177·9	75·2	180·2	78·0	182·7	80·9	185·2	83·9	187·9	86·9	190·7	90·0
47	179·0	75·1	181·2	77·9	183·6	80·8	186·1	83·8	188·7	86·8	191·4	90·0	194·3	93·2
48	182·5	77·8	184·7	80·7	187·1	83·7	189·6	86·8	192·3	89·9	195·1	93·2	198·0	96·5
49	186·1	80·5	188·4	83·6	190·9	86·7	192·4	89·9	196·1	93·2	199·0	96·5	202·0	100·0
50	189·9	83·4	192·3	86·6	194·8	89·8	197·4	93·1	200·2	96·5	203·1	100·0	206·1	103·6
51	194·0	86·5	196·4	89·7	199·0	93·1	201·6	96·5	204·5	100·0	207·4	103·6	210·5	107·3
52	198·3	89·6	200·0	93·0	203·4	96·4	206·1	100·0	209·0	103·6	212·0	107·4	215·2	111·3
53	202·8	92·9	205·4	96·4	208·1	100·0	210·9	103·7	213·8	107·5	216·9	111·3	220·2	115·4
54	207·7	96·4	210·3	100·0	213·0	103·7	215·9	107·5	218·9	111·5	222·1	115·5	225·4	119·6
55	212·8	100·0	215·5	103·8	218·3	107·6	221·2	111·6	224·3	115·6	227·6	119·8	231·0	124·1
56	218·3	103·8	221·0	107·7	223·9	111·7	226·9	115·8	230·1	120·1	233·4	124·4	237·0	128·9
57	224·1	107·8	226·9	111·9	229·9	116·0	233·0	120·3	236·3	124·7	239·7	129·2	243·3	133·9
58	230·4	112·1	233·3	116·3	236·3	120·6	239·5	125·0	242·8	129·6	246·3	134·3	250·0	139·1
59	237·0	116·5	240·0	121·0	243·1	125·4	246·4	130·0	249·8	134·8	253·5	139·7	257·3	144·7
60	244·2	121·3	247·2	125·8	250·4	130·5	253·8	135·3	257·4	140·3	261·1	145·3	265·0	150·6
61	251·8	126·3	255·0	131·1	258·3	135·9	261·8	140·9	265·4	146·1	269·3	151·4	273·3	156·8
62	260·0	131·7	263·2	136·6	266·7	141·7	270·3	146·9	274·1	152·3	278·1	157·8	282·2	163·5
63	268·9	137·4	272·3	142·6	275·8	147·9	279·5	153·3	283·4	158·9	287·5	164·7	291·9	170·6
64	278·5	143·6	282·0	149·0	285·6	154·5	289·5	160·2	293·5	166·0	297·8	172·0	302·3	178·2
65	288·9	150·2	292·4	155·8	296·3	161·6	300·3	167·5	304·5	173·7	308·9	179·9	313·5	186·4
66	300·1	157·3	303·9	163·2	307·9	169·2	312·0	175·5	316·4	181·9	321·0	188·5	325·8	195·2
67	312·4	165·0	316·3	171·2	320·5	177·5	324·8	184·1	329·3	190·8	334·1	197·7	339·1	204·8
68	325·9	173·3	330·0	179·8	334·2	186·5	338·8	193·4	343·5	200·4	348·5	207·7	353·7	215·1
69	340·7	182·4	344·9	189·3	349·4	196·3	354·1	203·5	359·1	211·0	364·3	218·6	369·7	226·5
70	356·9	192·4	361·4	199·6	366·1	207·0	371·0	214·6	376·2	222·5	381·7	230·5	387·4	238·8
71	375·0	203·4	379·7	211·0	384·6	218·8	389·8	226·9	395·2	235·2	401·0	243·7	407·0	252·5
72	395·1	215·5	400·0	223·6	405·2	231·9	410·7	240·5	416·4	249·2	422·4	258·2	428·8	267·5
73	417·5	229·0	422·8	237·6	428·3	246·5	434·0	255·5	440·1	264·9	446·5	274·5	453·2	284·3
74	442·9	244·2	448·4	253·4	454·3	262·8	460·4	272·5	466·8	282·4	473·6	292·6	480·7	303·2
75	471·7	261·3	477·6	271·1	483·8	281·2	490·3	291·6	497·2	302·2	504·4	313·3	511·9	324·5
76	504·6	280·8	510·9	291·4	517·6	302·2	524·6	313·4	531·9	324·8	539·6	336·5	547·7	348·7
77	542·7	303·3	549·5	314·7	556·6	326·4	564·1	338·4	572·0	350·8	580·3	363·5	589·0	376·5
78	587·2	329·4	594·5	341·8	602·2	354·5	610·4	367·6	618·9	381·0	627·9	394·8	637·3	409·0
79	639·8	360·2	647·8	373·8	656·2	387·7	665·1	401·9	674·4	416·6	684·1	431·7	694·4	447·2
80	703·0	397·1	711·8	412·1	721·1	427·4	730·8	443·1	741·0	459·2	751·8	475·9	763·0	493·0

	42°		43°		44°		45°		46°		47°		48°	
°	M	N	M	N	M	N	M	N	M	N	M	N	M	N
42	181·1	81·1												
43	184·0	84·0	187·0	87·0										
44	187·1	86·9	190·1	90·0	193·3	93·3								
45	190·3	90·0	193·4	93·3	196·6	96·6	200·0	100·0						
46	193·7	93·2	196·8	96·6	200·1	100·0	203·6	103·5	207·2	107·2				
47	197·3	96·6	200·5	100·0	203·8	103·6	207·4	107·2	211·1	111·0	215·0	115·0		
48	201·1	100·0	204·3	103·6	207·8	107·3	211·3	111·1	215·1	115·0	219·1	119·1	223·3	123·3
49	205·1	103·6	208·4	107·3	211·9	111·1	215·6	115·0	219·4	119·1	223·5	123·4	227·8	127·8
50	209·3	107·3	212·7	111·1	216·3	115·1	220·0	119·2	224·0	123·4	228·2	127·8	232·5	132·4
51	213·8	111·2	217·3	115·2	220·9	119·3	224·7	123·5	228·7	127·9	233·0	132·4	237·5	137·2
52	218·6	115·2	222·1	119·4	225·8	123·6	229·7	128·0	233·8	132·5	238·2	137·3	242·7	142·2
53	223·6	119·5	227·2	123·7	231·0	128·2	235·0	132·7	239·2	137·4	243·6	142·3	248·3	147·4
54	228·9	123·9	232·6	128·3	236·5	132·9	240·6	137·6	244·9	142·5	249·5	147·6	254·3	152·9
55	234·6	128·6	238·4	133·2	242·4	137·9	246·6	142·8	251·0	147·9	255·6	153·1	260·6	158·6
56	240·6	133·5	244·5	138·2	248·6	143·2	252·9	148·3	257·4	153·5	262·2	159·0	267·3	164·7
57	247·7	138·6	251·0	143·6	255·2	148·7	259·7	154·0	264·3	159·5	269·2	165·1	274·4	171·0
58	253·9	144·1	258·0	149·2	262·3	154·5	266·9	160·0	271·7	165·7	276·7	171·6	282·0	177·7
59	261·3	149·9	265·5	155·2	269·9	160·7	274·6	166·4	279·5	172·3	284·7	178·5	290·2	184·8
60	269·1	156·0	273·5	161·5	278·0	167·3	282·8	173·2	287·9	179·4	293·3	185·7	298·9	192·4
61	277·6	162·4	282·0	168·2	286·7	174·2	291·7	180·4	296·9	186·8	302·4	193·5	308·3	200·4

SPHERICAL TRAVERSE TABLE

°	42° M	42° N	43° M	43° N	44° M	44° N	45° M	45° N	46° M	46° N	47° M	47° N	48° M	48° N
62	286·6	169·3	291·2	175·4	296·1	181·6	301·2	188·1	306·6	194·8	312·3	201·7	318·3	208·9
63	296·4	176·7	301·2	183·0	306·2	189·5	311·5	196·3	317·1	203·2	323·0	210·5	329·2	218·0
64	307·0	184·6	311·9	191·2	317·3	198·0	322·6	205·0	328·4	212·3	334·5	219·9	340·9	227·7
65	318·4	193·1	323·5	200·0	328·9	207·1	334·6	214·4	340·6	222·1	347·0	230·0	353·6	238·2
66	330·8	202·2	336·2	209·4	341·8	216·9	347·7	224·6	353·9	232·6	360·5	240·9	367·4	249·5
67	344·4	212·1	349·9	219·7	355·8	227·5	361·9	235·6	368·4	244·0	375·3	252·6	382·5	261·7
68	359·2	222·9	365·1	230·8	371·1	239·0	377·5	247·5	384·3	256·3	391·4	265·4	398·9	274·9
69	375·5	234·6	381·5	242·9	387·9	251·6	394·6	260·5	401·7	269·8	409·2	279·4	417·0	289·3
70	393·4	247·4	399·8	256·2	406·5	265·3	413·5	274·7	420·9	284·5	428·7	294·6	437·0	305·1
71	413·3	261·5	420·0	270·8	427·0	280·5	434·4	290·4	442·2	300·7	450·4	311·4	459·0	322·6
72	435·5	277·1	442·5	287·0	449·9	297·2	457·6	307·8	465·9	318·7	474·5	330·0	483·6	341·8
73	460·2	294·5	467·7	305·0	475·5	315·9	483·7	327·1	492·4	338·7	501·5	350·8	511·2	363·3
74	488·2	314·0	496·1	325·2	504·3	336·8	513·1	348·7	522·3	361·1	532·0	374·0	542·2	387·3
75	519·9	336·2	528·3	348·0	537·1	360·4	546·4	373·2	556·2	386·5	566·5	400·2	577·4	414·5
76	556·2	361·1	565·2	374·0	574·6	387·3	584·6	401·1	595·0	415·3	606·1	430·1	617·7	445·5
77	598·2	390·0	607·8	403·9	618·0	418·3	628·7	433·2	639·9	448·5	651·8	464·5	664·4	481·1
78	647·2	423·6	657·6	438·7	668·6	453·4	680·2	470·5	692·4	487·2	705·2	504·5	718·8	522·5
79	705·2	463·2	716·6	479·7	728·6	496·8	741·2	514·5	754·4	532·7	768·5	551·7	783·2	571·4
80	774·9	510·6	787·4	528·9	800·6	547·7	814·4	567·1	829·0	587·3	844·4	608·2	860·6	629·9

°	49° M	49° N	50° M	50° N	51° M	51° N	52° M	52° N	53° M	53° N	54° M	54° N	55° M	55° N
49	232·3	132·3												
50	237·1	137·1	242·0	142·0										
51	242·2	142·1	247·2	147·2	252·5	152·5								
52	247·6	147·2	252·7	152·5	258·1	158·1	263·8	163·8						
53	253·3	152·7	258·5	158·2	264·0	163·9	269·9	169·9	276·1	176·1				
54	259·3	158·3	264·7	164·0	270·3	170·0	276·3	176·2	282·7	182·7	289·4	189·4		
55	265·7	164·3	271·2	170·2	277·0	176·4	283·2	182·8	289·7	189·5	296·6	196·6	304·0	204·0
56	272·6	170·5	278·2	176·7	284·2	183·1	290·5	189·8	297·2	196·7	304·2	204·1	311·8	211·7
57	279·9	177·1	285·6	183·5	291·8	190·2	298·2	197·1	305·1	204·3	312·4	211·9	320·1	219·9
58	287·6	184·1	293·6	190·7	299·9	197·6	306·5	204·8	313·6	212·4	321·0	220·3	329·0	228·5
59	296·0	191·5	302·1	198·3	308·5	205·5	315·4	213·0	322·6	220·9	330·3	229·1	338·5	237·7
60	304·9	199·2	311·1	206·4	317·8	213·9	324·9	221·7	332·3	229·9	340·3	238·4	348·7	247·4
61	314·4	207·5	320·9	215·0	327·8	222·8	335·0	230·9	342·7	239·4	350·9	248·3	359·6	257·6
62	324·7	216·4	331·4	224·1	338·5	232·3	346·0	240·7	353·9	249·6	362·4	258·9	371·3	268·6
63	335·7	225·8	342·7	233·9	350·0	242·4	357·8	251·2	366·0	260·4	374·7	270·1	384·0	280·3
64	347·7	235·9	354·9	244·3	362·5	253·2	370·5	262·4	379·1	272·1	388·1	282·2	397·7	292·8
65	360·7	246·7	368·1	255·6	376·0	264·8	384·3	274·5	393·2	284·6	402·6	295·2	412·5	306·3
66	374·8	258·4	382·5	267·7	390·6	277·4	399·3	287·5	408·5	298·1	418·3	309·1	418·9	320·8
67	390·1	271·0	398·2	280·8	406·6	290·9	415·7	301·5	425·3	312·6	435·4	324·3	446·2	336·4
68	406·9	284·7	415·3	295·0	424·1	305·6	433·6	316·8	443·6	328·5	454·2	340·7	465·4	353·5
69	425·3	299·7	434·1	310·5	443·3	321·7	453·2	333·4	463·7	345·7	474·7	358·6	486·5	372·0
70	445·7	316·1	454·9	327·2	464·6	339·3	474·9	351·7	485·8	364·6	497·4	378·2	509·8	392·4
71	468·2	334·1	477·8	346·1	488·1	358·6	498·9	371·7	510·4	385·4	522·6	399·7	535·5	414·8
72	493·3	354·0	503·4	366·8	514·2	380·1	525·6	393·9	537·7	408·4	550·6	423·6	564·2	439·5
73	521·3	376·3	532·1	389·8	543·5	403·9	555·5	418·6	568·3	434·1	581·9	450·2	596·3	467·1
74	553·0	401·2	564·4	415·6	576·5	430·7	589·3	446·4	602·8	462·8	617·2	480·0	632·5	498·0
75	588·9	429·3	601·1	444·8	613·9	460·9	627·6	477·7	642·0	495·3	657·3	513·7	673·6	533·0
76	630·1	461·4	643·1	478·0	656·8	495·3	671·4	513·4	686·8	532·3	703·2	552·0	720·7	572·8
77	677·6	498·3	691·6	516·2	706·4	534·9	722·1	554·4	738·7	574·8	756·3	596·2	775·0	618·6
78	733·1	541·2	748·3	560·7	764·3	581·0	781·2	602·2	799·2	624·3	818·3	647·5	838·6	671·5
79	798·8	591·8	815·3	613·1	832·8	635·3	851·3	658·5	870·8	682·7	891·6	708·1	913·7	734·7
80	877·8	652·4	895·9	675·9	915·1	700·3	935·4	725·9	950·6	752·6	979·7	780·6	1004	809·9

SPHERICAL TRAVERSE TABLE

°	56° M	56° N	57° M	57° N	58° M	58° N	59° M	59° N	60° M	60° N	61° M	61° N	62° M	62° N
56	319·8	219·8												
57	328·3	228·3	337·1	237·2										
58	337·5	237·3	346·5	246·4	356·1	256·1								
59	347·2	246·7	356·5	256·3	366·4	266·3	377·0	277·0						
60	357·7	256·8	367·2	266·1	377·4	277·2	383·3	288·3	400·0	300·0				
61	368·9	267·5	378·7	277·8	389·5	288·7	400·5	300·2	412·5	312·5	425·5	325·5		
62	380·9	278·8	391·1	289·6	402·0	301·0	413·6	313·0	426·0	325·8	439·4	339·3	453·7	353·7
63	393·9	291·0	404·4	302·2	415·7	314·1	427·7	326·6	440·5	339·9	454·3	354·1	469·2	369·1
64	407·9	303·9	418·8	315·7	430·5	328·1	442·9	341·2	456·2	355·1	470·5	36[illegible]·9	485·9	385·6
65	423·1	317·9	434·0	330·2	446·5	343·2	459·4	356·9	473·2	371·4	488·1	386·9	504·0	403·3
66	439·7	333·0	451·4	345·9	464·0	359·4	477·4	373·8	491·7	389·0	507·1	405·2	523·7	422·4
67	457·7	349·3	469·9	362·8	483·0	377·0	496·9	392·1	511·9	398·8	527·9	425·0	545·1	443·1
68	477·4	366·9	490·1	381·1	503·7	396·1	518·3	411·9	533·9	428·7	550·6	446·5	568·6	465·5
69	499·0	386·2	512·3	401·1	526·6	416·9	541·8	433·6	558·1	451·2	575·6	470·0	594·4	489·9
70	522·9	407·3	536·8	423·1	551·7	429·7	567·7	457·3	584·8	475·9	603·1	495·7	622·8	516·7
71	549·3	430·6	564·0	447·2	579·6	464·8	596·4	483·3	614·3	503·0	633·6	523·9	654·3	546·2
72	578·7	456·3	594·2	473·9	610·7	492·5	628·3	512·2	647·2	533·1	667·5	555·2	689·3	578·8
73	611·6	484·9	628·0	503·7	645·4	523·4	664·1	544·4	684·1	566·7	705·5	590·1	728·5	615·2
74	648·8	517·0	666·1	537·0	684·6	558·1	704·4	580·5	725·6	604·0	748·3	629·1	772·8	655·9
75	690·9	553·3	709·4	574·7	729·1	597·3	756·2	621·1	772·7	646·4	796·9	673·3	823·0	701·9
76	739·2	594·6	758·9	617·6	780·0	641·9	802·6	667·5	826·7	694·7	852·6	723·6	880·5	754·3
77	795·0	642·2	816·2	667·0	838·9	693·2	863·1	720·9	889·1	750·2	916·9	781·4	946·9	814·6
78	860·1	697·5	883·1	724·5	907·6	752·9	933·9	783·0	961·9	814·9	992·1	848·8	1024	884·8
79	937·2	762·7	962·3	792·2	989·0	823·3	1018	856·2	1048	891·1	1081	928·1	1116	967·6
80	1030	840·8	1057	873·3	1087	907·6	1118	943·9	1152	982·3	1188	1023	1227	1067

°	63° M	63° N	64° M	64° N	65° M	65° N	66° M	66° N	67° M	67° N	68° M	68° N	69° M	69° N
63	485·2	385·2												
64	502·5	402·4	520·4	420·4										
65	521·2	420·9	539·8	439·7	559·9	459·9								
66	541·6	440·8	560·9	460·5	581·8	481·7	604·5	504·5						
67	563·7	462·4	583·8	483·0	605·6	505·2	629·2	529·1	655·0	555·0				
68	588·0	485·8	608·9	507·5	631·6	530·8	656·3	555·9	683·2	583·1	712·6	612·6		
69	614·6	511·3	636·5	534·1	660·3	558·7	686·1	595·1	714·2	613·7	744·9	644·8	778·6	678·6
70	644·0	539·2	667·0	563·3	691·8	589·2	718·9	617·1	748·3	647·3	780·5	680·0	815·9	715·7
71	676·6	570·0	700·7	595·4	726·8	622·8	755·2	652·3	786·1	684·2	819·9	718·8	857·1	756·6
72	712·8	604·0	738·2	631·0	765·7	660·0	795·6	691·3	828·2	725·1	863·9	761·7	903·0	801·8
73	753·4	641·9	780·2	670·6	809·3	701·4	840·9	734·6	875·3	770·6	913·0	809·6	954·4	852·1
74	799·1	684·4	827·6	715·0	858·4	747·9	892·0	783·3	928·5	821·6	968·5	863·2	1002	908·5
75	851·0	732·5	881·4	765·2	914·2	800·4	949·9	838·2	988·8	879·2	1031	923·7	1078	972·2
76	910·5	787·2	942·9	822·3	978·1	860·1	1016	900·8	1058	944·9	1103	992·7	1153	1045
77	979·2	850·1	1014	888·1	1052	928·9	1093	972·9	1138	1020	1187	1072	1241	1128
78	1059	923·3	1097	964·6	1087	1009	1183	1057	1231	1108	1284	1164	1342	1226
79	1154	1010	1196	1055	1240	1103	1288	1155	1341	1212	1399	1273	1462	1340
80	1268	1113	1314	1163	1363	1216	1416	1274	1474	1336	1537	1404	1607	1477

°	70° M	70° N	71° M	71° N	72° M	72° N	73° M	73° N	74° M	74° N	75° M	75° N	76° M	76° N
70	854·9	754·9												
71	898·1	797·9	943·5	843·5										
72	946·2	845·6	994·0	893·8	1047	947·2								
73	1000	898·6	1051	949·9	1107	1008	1170	1070						
74	1061	958·1	1114	1013	1174	1073	1241	1141	1316	1216				
75	1130	1025	1187	1084	1250	1149	1321	1221	1402	1301	1493	1394		
76	1209	1102	1270	1165	1338	1234	1414	1312	1500	1399	1597	1497	1709	1609
77	1300	1190	1366	1258	1439	1333	1520	1417	1613	1511	1718	1617	1838	1737
78	1406	1293	1477	1366	1556	1448	1645	1539	1745	1641	1858	1756	1988	1887
79	1532	1413	1610	1494	1696	1583	1793	1683	1901	1794	2025	1920	2116	2063
80	1684	1558	1769	1647	1864	1745	1970	1856	2089	1978	2225	2117	2380	2275

MERIDIONAL PARTS

LATITUDE

′	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	17°	18°
0	0	60	120	180	240	300	361	421	482	542	603	664	725	787	848	910	973	1035	1098
1	1	61	121	181	241	301	362	422	483	543	604	665	726	788	850	911	974	1036	1099
2	2	62	122	182	242	302	363	423	484	544	605	666	727	789	851	913	975	1037	1100
3	3	63	123	183	243	303	364	424	485	545	606	667	728	790	852	914	976	1038	1101
4	4	64	124	184	244	304	365	425	486	546	607	668	729	791	853	915	977	1039	1102
5	5	65	125	185	245	305	366	426	487	547	608	669	730	792	854	916	978	1041	1103
6	6	66	126	186	246	306	367	427	488	548	609	670	731	793	855	917	979	1042	1105
7	7	67	127	187	247	307	368	428	489	549	610	671	732	794	856	918	980	1043	1106
8	8	68	128	188	248	308	369	429	490	550	611	672	734	795	857	919	981	1044	1107
9	9	69	129	189	249	309	370	430	491	551	612	673	735	796	858	920	982	1045	1108
10	10	70	130	190	250	310	371	431	492	552	613	674	736	797	859	921	983	1046	1109
11	11	71	131	191	251	311	372	432	493	553	614	675	737	798	860	922	984	1047	1110
12	12	72	132	192	252	312	373	433	494	554	615	676	738	799	861	923	985	1048	1111
13	13	73	133	193	253	313	374	434	495	555	616	677	739	800	862	924	986	1049	1112
14	14	74	134	194	254	314	375	435	496	556	617	678	740	801	863	925	987	1050	1113
15	15	75	135	195	255	315	376	436	497	557	618	679	741	802	864	926	988	1051	1114
16	16	76	136	196	256	316	377	437	498	558	619	680	742	803	865	927	989	1052	1115
17	17	77	137	197	257	317	378	438	499	559	620	681	743	804	866	928	990	1053	1116
18	18	78	138	198	258	318	379	439	500	560	621	682	744	805	867	929	991	1054	1117
19	19	79	139	199	259	319	380	440	501	561	622	683	745	806	868	930	993	1055	1118
20	20	80	140	200	260	320	381	441	502	562	623	684	746	807	869	931	994	1056	1119
21	21	81	141	201	261	321	382	442	503	564	624	685	747	808	870	932	995	1057	1120
22	22	82	142	202	262	322	383	443	504	565	625	687	748	809	871	933	996	1058	1121
23	23	83	143	203	263	323	384	444	505	566	626	688	749	810	872	934	997	1059	1122
24	24	84	144	204	264	324	385	445	506	567	627	689	750	811	873	935	998	1060	1123
25	25	85	145	205	265	325	386	446	507	568	628	690	751	812	874	936	999	1061	1125
26	26	86	146	206	266	326	387	447	508	569	629	691	752	813	875	937	1000	1063	1126
27	27	87	147	207	267	327	388	448	509	570	631	692	753	815	876	938	1001	1064	1127
28	28	88	148	208	268	328	389	449	510	571	632	693	754	816	877	939	1002	1065	1128
29	29	89	149	209	269	330	390	450	511	572	633	694	755	817	878	941	1003	1066	1129
30	30	90	150	210	270	331	391	451	512	573	634	695	756	818	879	942	1004	1067	1130
31	31	91	151	211	271	332	392	452	513	574	635	696	757	819	880	943	1005	1068	1131
32	32	92	152	212	272	333	393	453	514	575	636	697	758	820	882	944	1006	1069	1132
33	33	93	153	213	273	334	394	454	515	576	637	698	759	821	883	945	1007	1070	1133
34	34	94	154	214	274	335	395	455	516	577	638	699	760	822	884	946	1008	1071	1134
35	35	95	155	215	275	336	396	456	517	578	639	700	761	823	885	947	1009	1072	1135
36	36	96	156	216	276	337	397	457	518	579	640	701	762	824	886	948	1010	1073	1136
37	37	97	157	217	277	338	398	458	519	580	641	702	763	825	887	949	1011	1074	1137
38	38	98	158	218	278	339	399	459	520	581	642	703	764	826	888	950	1012	1075	1138
39	39	99	159	219	279	340	400	460	521	582	643	704	765	827	889	951	1013	1076	1139
40	40	100	160	220	280	341	401	461	522	583	644	705	766	828	890	952	1014	1077	1140
41	41	101	161	221	281	342	402	462	523	584	645	706	767	829	891	953	1015	1078	1141
42	42	102	162	222	282	343	403	463	524	585	646	707	768	830	892	954	1016	1079	1142
43	43	103	163	223	283	344	404	464	525	586	647	708	769	831	893	955	1018	1080	1144
44	44	104	164	224	284	345	405	465	526	587	648	709	770	832	894	956	1019	1081	1145
45	45	105	165	225	285	346	406	466	527	588	649	710	771	833	895	957	1020	1082	1146
46	46	106	166	226	286	347	407	467	528	589	650	711	772	834	896	958	1021	1084	1147
47	47	107	167	227	287	348	408	468	529	590	651	712	773	835	897	959	1022	1085	1148
48	48	108	168	228	288	349	409	469	530	591	652	713	774	836	898	960	1023	1086	1149
49	49	109	169	229	289	350	410	470	531	592	653	714	775	837	899	961	1024	1087	1150
50	50	110	170	230	290	351	411	471	532	593	654	715	777	838	900	962	1025	1088	1151
51	51	111	171	231	291	352	412	472	533	594	655	716	778	839	901	963	1026	1089	1152
52	52	112	172	232	292	353	413	473	534	595	656	717	779	840	902	964	1027	1090	1153
53	53	113	173	233	293	354	414	474	535	596	657	718	780	841	903	965	1028	1091	1154
54	54	114	174	234	294	355	415	476	536	597	658	719	781	842	904	966	1029	1092	1155
55	55	115	175	235	295	356	416	477	537	598	659	720	782	843	905	968	1030	1093	1156
56	56	116	176	236	296	357	417	478	538	599	660	721	783	844	906	969	1031	1094	1157
57	57	117	177	237	297	358	418	479	539	600	661	722	784	845	907	970	1032	1095	1158
58	58	118	178	238	298	359	419	480	540	601	662	723	785	846	908	971	1033	1096	1159
59	59	119	179	239	299	360	420	481	541	602	663	724	786	847	909	972	1034	1097	1160
	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	17°	18°

MERIDIONAL PARTS

LATITUDE

′	19°	20°	21°	22°	23°	24°	25°	26°	27°	28°	29°	30°	31°	32°	33°
0	1161	1225	1289	1354	1419	1484	1550	1616	1684	1751	1819	1888	1958	2028	2100
1	1163	1226	1290	1355	1420	1485	1551	1618	1685	1752	1821	1890	1959	2030	2101
2	1164	1227	1291	1356	1421	1486	1552	1619	1686	1753	1822	1891	1960	2031	2102
3	1165	1228	1292	1357	1422	1487	1553	1620	1687	1755	1823	1892	1962	2032	2103
4	1166	1229	1293	1358	1423	1488	1554	1621	1688	1756	1824	1893	1963	2033	2104
5	1167	1230	1295	1359	1424	1490	1556	1622	1689	1757	1825	1894	1964	2034	2105
6	1168	1232	1296	1360	1425	1491	1557	1623	1690	1758	1826	1895	1965	2035	2107
7	1169	1233	1297	1361	1426	1492	1558	1624	1691	1759	1827	1896	1966	2037	2108
8	1170	1234	1298	1362	1427	1493	1559	1625	1693	1760	1829	1898	1967	2038	2109
9	1171	1235	1299	1363	1428	1494	1560	1626	1694	1761	1830	1899	1969	2039	2110
10	1172	1236	1300	1364	1430	1495	1561	1628	1695	1762	1831	1900	1970	2040	2111
11	1173	1237	1301	1366	1431	1496	1562	1629	1696	1764	1832	1901	1971	2041	2113
12	1174	1238	1302	1367	1432	1497	1563	1630	1697	1765	1833	1902	1972	2043	2114
13	1175	1239	1303	1368	1433	1498	1564	1631	1698	1766	1834	1903	1973	2044	2115
14	1176	1240	1304	1369	1434	1499	1565	1632	1699	1767	1835	1905	1974	2045	2116
15	1177	1241	1305	1370	1435	1500	1567	1633	1700	1768	1837	1906	1976	2046	2117
16	1178	1242	1306	1371	1436	1502	1568	1634	1701	1769	1838	1907	1977	2047	2119
17	1179	1243	1307	1372	1437	1503	1569	1635	1703	1770	1839	1908	1978	2048	2120
18	1181	1244	1308	1373	1438	1504	1570	1637	1704	1772	1840	1909	1979	2050	2121
19	1182	1245	1310	1374	1439	1505	1571	1638	1705	1773	1841	1910	1980	2051	2122
20	1183	1246	1311	1375	1440	1506	1572	1639	1706	1774	1842	1912	1981	2052	2123
21	1184	1248	1312	1376	1441	1507	1573	1640	1707	1775	1843	1913	1983	2053	2125
22	1185	1249	1313	1377	1443	1508	1574	1641	1708	1776	1845	1914	1984	2054	2126
23	1186	1250	1314	1379	1444	1509	1575	1642	1709	1777	1846	1915	1985	2056	2127
24	1187	1251	1315	1380	1445	1510	1577	1643	1711	1778	1847	1916	1986	2057	2128
25	1188	1252	1316	1381	1446	1511	1578	1644	1712	1780	1848	1917	1987	2058	2129
26	1189	1253	1317	1382	1447	1513	1579	1645	1713	1781	1849	1918	1988	2059	2131
27	1190	1254	1318	1383	1448	1514	1580	1647	1714	1782	1850	1920	1990	2060	2132
28	1191	1255	1319	1384	1449	1515	1581	1648	1715	1783	1852	1921	1991	2061	2133
29	1192	1256	1320	1385	1450	1516	1582	1649	1716	1784	1853	1922	1992	2063	2134
30	1193	1257	1321	1386	1451	1517	1583	1650	1717	1785	1854	1923	1993	2064	2135
31	1194	1258	1322	1387	1452	1518	1584	1651	1718	1786	1855	1924	1994	2065	2137
32	1195	1259	1324	1388	1453	1519	1585	1652	1720	1787	1856	1925	1995	2066	2138
33	1196	1260	1325	1389	1455	1520	1586	1653	1721	1789	1857	1927	1997	2067	2139
34	1198	1261	1326	1390	1456	1521	1588	1654	1722	1790	1858	1928	1998	2069	2140
35	1199	1262	1327	1392	1457	1522	1589	1656	1723	1791	1860	1929	1999	2070	2141
36	1200	1264	1328	1393	1458	1524	1590	1657	1724	1792	1861	1930	2000	2071	2143
37	1201	1265	1329	1394	1459	1525	1591	1658	1725	1793	1862	1931	2001	2072	2144
38	1202	1266	1330	1395	1460	1526	1592	1659	1726	1794	1863	1932	2002	2073	2145
39	1203	1267	1331	1396	1461	1527	1593	1660	1727	1795	1864	1934	2004	2075	2146
40	1204	1268	1332	1397	1462	1528	1594	1661	1729	1797	1865	1935	2005	2076	2147
41	1205	1269	1333	1398	1463	1529	1595	1662	1730	1798	1866	1936	2006	2077	2149
42	1206	1270	1334	1399	1464	1530	1596	1663	1731	1799	1868	1937	2007	2078	2150
43	1207	1271	1335	1400	1465	1531	1598	1664	1732	1800	1869	1938	2008	2079	2151
44	1208	1272	1336	1401	1467	1532	1599	1666	1733	1801	1870	1939	2010	2080	2152
45	1209	1273	1338	1402	1468	1533	1600	1667	1734	1802	1871	1941	2011	2082	2153
46	1210	1274	1339	1403	1469	1535	1601	1668	1735	1803	1872	1942	2012	2083	2155
47	1211	1275	1340	1405	1470	1536	1602	1669	1736	1805	1873	1943	2013	2084	2156
48	1212	1276	1341	1406	1471	1537	1603	1670	1738	1806	1875	1944	2014	2085	2157
49	1213	1277	1342	1407	1472	1538	1604	1671	1739	1807	1876	1945	2015	2086	2158
50	1215	1278	1343	1408	1473	1539	1605	1672	1740	1808	1877	1946	2017	2088	2159
51	1216	1280	1344	1409	1474	1540	1606	1673	1741	1809	1878	1948	2018	2089	2161
52	1217	1281	1345	1410	1475	1541	1608	1675	1742	1810	1879	1949	2019	2090	2162
53	1218	1282	1346	1411	1476	1542	1609	1676	1743	1811	1880	1950	2020	2091	2163
54	1219	1283	1347	1412	1477	1543	1610	1677	1744	1813	1881	1951	2021	2092	2164
55	1220	1284	1348	1413	1479	1544	1611	1678	1746	1814	1883	1952	2022	2094	2165
56	1221	1285	1349	1414	1480	1546	1612	1679	1747	1815	1884	1953	2024	2095	2167
57	1222	1286	1350	1415	1481	1547	1613	1680	1748	1816	1885	1955	2025	2096	2168
58	1223	1287	1352	1416	1482	1548	1614	1681	1749	1817	1886	1956	2026	2097	2169
59	1224	1288	1353	1418	1483	1549	1615	1682	1750	1818	1887	1957	2027	2098	2170
′	19°	20°	21°	22°	23°	24°	25°	26°	27°	28°	29°	30°	31°	32°	33°

MERIDIONAL PARTS

LATITUDE

′	34°	35°	36°	37°	38°	39°	40°	41°	42°	43°	44°	45°	46°	47°	48°
0	2171	2244	2318	2393	2468	2545	2623	2702	2782	2863	2946	3030	3116	3203	3292
1	2173	2246	2319	2394	2470	2546	2624	2703	2783	2864	2947	3031	3117	3204	3293
2	2174	2247	2320	2395	2471	2548	2625	2704	2784	2866	2949	3033	3118	3206	3295
3	2175	2248	2322	2396	2472	2549	2627	2706	2786	2867	2950	3034	3120	3207	3296
4	2176	2249	2323	2398	2473	2550	2628	2707	2787	2869	2951	3036	3121	3209	3298
5	2178	2250	2324	2399	2475	2551	2629	2708	2788	2870	2953	3037	3123	3210	3299
6	2179	2252	2325	2400	2476	2553	2631	2710	2790	2871	2954	3038	3124	3212	3301
7	2180	2253	2327	2401	2477	2554	2632	2711	2791	2873	2956	3040	3126	3213	3302
8	2181	2254	2328	2403	2478	2555	2633	2712	2792	2874	2957	3041	3127	3214	3303
9	2182	2255	2329	2404	2480	2557	2634	2714	2794	2875	2958	3043	3129	3216	3305
10	2184	2257	2330	2405	2481	2558	2636	2715	2795	2877	2960	3044	3130	3217	3306
11	2185	2258	2332	2406	2482	2559	2637	2716	2797	2878	2961	3046	3131	3219	3308
12	2186	2259	2333	2408	2484	2560	2638	2718	2798	2880	2963	3047	3133	3220	3309
13	2187	2260	2334	2409	2485	2562	2640	2719	2799	2881	2964	3048	3134	3222	3311
14	2188	2261	2335	2410	2486	2563	2641	2720	2801	2882	2965	3050	3136	3223	3312
15	2190	2263	2337	2411	2487	2564	2642	2722	2802	2884	2967	3051	3137	3225	3314
16	2191	2264	2338	2413	2489	2566	2644	2723	2803	2885	2968	3053	3139	3226	3316
17	2192	2265	2339	2414	2490	2567	2645	2724	2805	2886	2970	3054	3140	3228	3317
18	2193	2266	2340	2415	2491	2568	2646	2726	2806	2888	2971	3055	3142	3229	3319
19	2194	2268	2342	2416	2492	2569	2648	2727	2807	2889	2972	3057	3143	3231	3320
20	2196	2269	2343	2418	2494	2571	2649	2728	2809	2891	2974	3058	3144	3232	3322
21	2197	2270	2344	2419	2495	2572	2650	2729	2810	2892	2975	3060	3146	3234	3323
22	2198	2271	2345	2420	2496	2573	2651	2731	2811	2893	2976	3061	3147	3235	3325
23	2199	2272	2346	2422	2498	2575	2653	2732	2813	2895	2978	3063	3149	3237	3326
24	2200	2274	2348	2423	2499	2576	2654	2733	2814	2896	2979	3064	3150	3238	3328
25	2202	2275	2349	2424	2500	2577	2655	2735	2815	2897	2981	3065	3152	3240	3329
26	2203	2276	2350	2425	2501	2578	2657	2736	2817	2899	2982	3067	3153	3241	3331
27	2204	2277	2351	2427	2503	2580	2658	2737	2818	2900	2983	3068	3155	3242	3332
28	2205	2279	2353	2428	2504	2581	2659	2739	2820	2902	2985	3070	3156	3244	3334
29	2207	2280	2354	2429	2505	2582	2661	2740	2821	2903	2986	3071	3157	3245	3335
30	2208	2281	2355	2430	2506	2584	2662	2742	2822	2904	2988	3073	3159	3247	3337
31	2209	2282	2356	2432	2508	2585	2663	2743	2824	2906	2989	3074	3160	3248	3338
32	2210	2283	2358	2433	2509	2586	2665	2744	2825	2907	2991	3075	3162	3250	3340
33	2211	2285	2359	2434	2510	2588	2666	2746	2826	2908	2992	3077	3163	3251	3341
34	2213	2286	2360	2435	2512	2589	2667	2747	2828	2910	2993	3078	3165	3253	3343
35	2214	2287	2361	2437	2513	2590	2669	2748	2829	2911	2995	3080	3166	3254	3344
36	2215	2288	2363	2438	2514	2591	2670	2750	2830	2913	2996	3081	3168	3256	3346
37	2216	2290	2364	2439	2515	2593	2671	2751	2832	2914	2998	3083	3169	3257	3347
38	2217	2291	2365	2440	2517	2594	2673	2752	2833	2915	2999	3084	3171	3259	3349
39	2219	2292	2366	2442	2518	2595	2674	2754	2834	2917	3000	3085	3172	3260	3350
40	2220	2293	2368	2443	2519	2597	2675	2755	2836	2918	3002	3087	3173	3262	3352
41	2221	2295	2369	2444	2521	2598	2676	2756	2837	2919	3003	3088	3175	3263	3353
42	2222	2296	2370	2445	2522	2599	2678	2758	2839	2921	3005	3090	3176	3265	3355
43	2224	2297	2371	2447	2523	2601	2679	2759	2840	2922	3006	3091	3178	3266	3356
44	2225	2298	2373	2448	2524	2602	2680	2760	2841	2924	3007	3093	3179	3268	3358
45	2226	2299	2374	2449	2526	2603	2682	2762	2843	2925	3009	3094	3181	3269	3359
46	2227	2301	2375	2451	2527	2604	2683	2763	2844	2926	3010	3095	3182	3271	3361
47	2228	2302	2376	2452	2528	2606	2684	2764	2845	2928	3012	3097	3184	3272	3362
48	2230	2303	2378	2453	2530	2607	2686	2766	2847	2929	3013	3098	3185	3274	3364
49	2231	2304	2379	2454	2531	2608	2687	2767	2848	2931	3014	3100	3187	3275	3365
50	2232	2306	2380	2456	2532	2610	2688	2768	2849	2932	3016	3101	3188	3277	3367
51	2233	2307	2381	2457	2533	2611	2690	2770	2851	2933	3017	3103	3190	3278	3368
52	2235	2308	2383	2458	2535	2612	2691	2771	2852	2935	3019	3104	3191	3280	3370
53	2236	2309	2384	2459	2536	2614	2692	2772	2854	2936	3020	3105	3192	3281	3371
54	2237	2311	2385	2461	2537	2615	2694	2774	2855	2937	3021	3107	3194	3283	3373
55	2238	2312	2386	2462	2538	2616	2695	2775	2856	2939	3023	3108	3195	3284	3374
56	2239	2313	2388	2463	2540	2617	2696	2776	2858	2940	3024	3110	3197	3286	3376
57	2241	2314	2389	2464	2541	2619	2698	2778	2859	2942	3026	3111	3198	3287	3378
58	2242	2316	2390	2466	2542	2620	2699	2779	2860	2943	3027	3113	3200	3289	3379
59	2243	2317	2391	2467	2544	2621	2700	2780	2862	2944	3029	3114	3201	3290	3381
′	34°	35°	36°	37°	38°	39°	40°	41°	42°	43°	44°	45°	46°	47°	48°

MERIDIONAL PARTS

LATITUDE

′	49°	50°	51°	52°	53°	54°	55°	56°	57°	58°	59°	60°	61°	62°	63°
0	3382	3474	3569	3665	3764	3865	3968	4074	4183	4294	4409	4527	4649	4775	4905
1	3384	3476	3570	3667	3765	3866	3970	4076	4184	4296	4411	4529	4651	4777	4907
2	3385	3478	3572	3668	3767	3868	3971	4077	4186	4298	4413	4531	4653	4779	4909
3	3387	3479	3574	3670	3769	3870	3973	4079	4188	4300	4415	4533	4655	4781	4912
4	3388	3481	3575	3672	3770	3871	3975	4081	4190	4302	4417	4535	4657	4784	4914
5	3390	3482	3577	3673	3772	3873	3977	4083	4192	4304	4419	4537	4660	4786	4916
6	3391	3484	3578	3675	3774	3875	3978	4085	4194	4306	4421	4539	4662	4788	4918
7	3393	3485	3580	3677	3775	3877	3980	4086	4195	4308	4423	4541	4664	4790	4920
8	3394	3487	3582	3678	3777	3878	3982	4088	4197	4309	4425	4543	4666	4792	4923
9	3396	3488	3583	3680	3779	3880	3984	4090	4199	4311	4427	4545	4668	4794	4925
10	3397	3490	3585	3681	3780	3882	3985	4092	4201	4313	4429	4547	4670	4796	4927
11	3399	3492	3586	3683	3782	3883	3987	4094	4203	4315	4431	4549	4672	4798	4929
12	3400	3493	3588	3685	3784	3885	3989	4095	4205	4317	4433	4551	4674	4801	4931
13	3402	3495	3590	3686	3785	3887	3991	4097	4207	4319	4434	4553	4676	4803	4934
14	3403	3496	3591	3688	3787	3889	3992	4099	4208	4321	4436	4555	4678	4805	4936
15	3405	3498	3593	3690	3789	3890	3994	4101	4210	4323	4438	4557	4680	4807	4938
16	3407	3499	3594	3691	3790	3892	3996	4103	4212	4325	4440	4559	4682	4809	4940
17	3408	3501	3596	3693	3792	3894	3998	4104	4214	4327	4442	4562	4684	4811	4943
18	3410	3503	3598	3695	3794	3895	3999	4106	4216	4328	4444	4564	4687	4814	4945
19	3411	3504	3599	3696	3795	3897	4001	4108	4218	4330	4446	4566	4689	4816	4947
20	3413	3506	3601	3698	3797	3899	4003	4110	4220	4332	4448	4568	4691	4818	4949
21	3414	3507	3602	3699	3799	3901	4005	4112	4221	4334	4450	4570	4693	4820	4951
22	3416	3509	3604	3701	3800	3902	4006	4113	4223	4336	4452	4572	4695	4822	4954
23	3417	3510	3606	3703	3802	3904	4008	4115	4225	4338	4454	4574	4697	4824	4956
24	3419	3512	3607	3704	3804	3906	4010	4117	4227	4340	4456	4576	4699	4826	4958
25	3420	3514	3609	3706	3806	3907	4012	4119	4229	4342	4458	4578	4791	4829	4960
26	3422	3515	3610	3708	3807	3909	4014	4121	4231	4344	4460	4580	4703	4831	4963
27	3423	3517	3612	3709	3809	3911	4015	4122	4232	4346	4462	4582	4705	4833	4965
28	3425	3518	3614	3711	3811	3913	4017	4124	4234	4347	4464	4584	4707	4835	4967
29	3427	3520	3615	3713	3812	3914	4019	4126	4236	4349	4466	4586	4710	4837	4969
30	3428	3521	3617	3714	3814	3916	4021	4128	4238	4351	4468	4588	4712	4839	4972
31	3430	3523	3618	3716	3816	3918	4022	4130	4240	4353	4470	4590	4714	4842	4974
32	3431	3525	3620	3717	3817	3919	4024	4132	4242	4355	4472	4592	4716	4844	4976
33	3433	3526	3622	3719	3819	3921	4026	4133	4244	4357	4474	4594	4718	4846	4978
34	3434	3528	3623	3721	3821	3923	4028	4135	4246	4359	4476	4596	4720	4848	4981
35	3436	3529	3625	3722	3822	3925	4029	4137	4247	4361	4478	4598	4722	4850	4983
36	3437	3531	3626	3724	3824	3926	4031	4139	4249	4363	4480	4600	4724	4852	4985
37	3439	3532	3628	3726	3826	3928	4033	4141	4251	4365	4482	4602	4726	4855	4987
38	3440	3534	3630	3727	3827	3930	4035	4142	4253	4367	4484	4604	4728	4857	4990
39	3442	3536	3631	3729	3829	3932	4037	4144	4255	4369	4486	4606	4731	4859	4992
40	3443	3537	3633	3731	3831	3933	4038	4146	4257	4370	4488	4608	4733	4861	4994
41	3445	3539	3634	3732	3832	3935	4040	4148	4259	4372	4490	4610	4735	4863	4996
42	3447	3540	3636	3734	3834	3937	4042	4150	4260	4374	4492	4612	4737	4865	4999
43	3448	3542	3638	3736	3836	3938	4044	4152	4262	4376	4494	4614	4739	4868	5001
44	3450	3543	3639	3737	3838	3940	4045	4153	4264	4378	4495	4616	4741	4870	5003
45	3451	3545	3641	3739	3839	3942	4047	4155	4266	4380	4497	4618	4743	4872	5005
46	3453	3547	3643	3741	3841	3944	4049	4157	4268	4382	4499	4620	4745	4874	5008
47	3454	3548	3644	3742	3843	3945	4051	4159	4270	4384	4501	4623	4747	4876	5010
48	3456	3550	3646	3744	3844	3947	4052	4161	4272	4386	4503	4625	4750	4879	5012
49	3457	3551	3647	3746	3846	3949	4054	4162	4274	4388	4505	4627	4752	4881	5014
50	3459	3553	3649	3747	3848	3951	4056	4164	4275	4390	4507	4629	4754	4883	5017
51	3460	3555	3651	3749	3849	3952	4058	4166	4277	4392	4509	4631	4756	4885	5019
52	3462	3556	3652	3750	3851	3954	4060	4168	4279	4394	4511	4633	4758	4887	5021
53	3464	3558	3654	3752	3853	3956	4061	4170	4281	4396	4513	4635	4760	4890	5023
54	3465	3559	3655	3754	3854	3958	4063	4172	4283	4398	4515	4637	4762	4892	5026
55	3467	3561	3657	3755	3856	3959	4065	4173	4285	4399	4517	4639	4764	4894	5028
56	3468	3562	3659	3757	3858	3961	4067	4175	4287	4401	4519	4641	4766	4896	5030
57	3470	3564	3660	3759	3860	3963	4069	4177	4289	4403	4521	4643	4769	4898	5033
58	3471	3566	3662	3760	3861	3964	4070	4179	4291	4405	4523	4645	4771	4901	5035
59	3473	3567	3664	3762	3863	3966	4072	4181	4292	4407	4525	4647	4773	4903	5037
	49°	50°	51°	52°	53°	54°	55°	56°	57°	58°	59°	60°	61°	62°	63°

MERIDIONAL PARTS

′	LATITUDE 64°	65°	66°	67°	68°	69°	70°	71°	72°	73°	74°	75°	76°	77°	78°
0	5039	5179	5324	5474	5631	5795	5966	6146	6335	6534	6746	6970	7210	7467	7744
1	5042	5181	5326	5477	5633	5797	5969	6149	6338	6538	6749	6974	7214	7472	7749
2	5044	5184	5328	5479	5636	5800	5972	6152	6341	6541	6753	6978	7218	7476	7754
3	5046	5186	5331	5482	5639	5803	5975	6155	6345	6545	6757	6982	7222	7481	7759
4	5049	5188	5333	5484	5642	5806	5978	6158	6348	6548	6760	6986	7227	7485	7764
5	5051	5191	5336	5487	5644	5809	5981	6161	6351	6552	6764	6990	7231	7490	7769
6	5053	5193	5338	5489	5647	5811	5984	6164	6354	6555	6768	6994	7235	7494	7774
7	5055	5195	5341	5492	5650	5814	5986	6167	6358	6558	6771	6997	7239	7498	7778
8	5058	5198	5343	5495	5652	5817	5989	6170	6361	6562	6775	7001	7243	7503	7783
9	5060	5200	5346	5497	5655	5820	5992	6173	6364	6565	6779	7005	7247	7507	7788
10	5062	5203	5348	5500	5658	5823	5995	6177	6367	6569	6782	7009	7252	7512	7793
11	5065	5205	5351	5502	5660	5825	5998	6180	6371	6572	6786	7013	7256	7516	7798
12	5067	5207	5353	5505	5663	5828	6001	6183	6374	6576	6790	7017	7260	7521	7803
13	5069	5210	5356	5507	5666	5831	6004	6186	6377	6579	6793	7021	7264	7525	7808
14	5071	5212	5358	5510	5668	5834	6007	6189	6380	6583	6797	7025	7268	7530	7813
15	5074	5214	5361	5513	5671	5837	6010	6192	6384	6586	6801	7029	7273	7535	7817
16	5076	5217	5363	5515	5674	5839	6013	6195	6387	6590	6804	7033	7277	7539	7822
17	5078	5219	5366	5518	5676	5842	6016	6198	6390	6593	6808	7037	7281	7544	7827
18	5081	5222	5368	5520	5679	5845	6019	6201	6394	6597	6812	7041	7285	7548	7832
19	5083	5224	5371	5523	5682	5848	6022	6205	6397	6600	6815	7045	7289	7553	7837
20	5085	5226	5373	5526	5685	5851	6025	6208	6400	6603	6819	7048	7294	7557	7842
21	5088	5229	5376	5528	5687	5854	6028	6211	6403	6607	6823	7052	7298	7562	7847
22	5090	5231	5378	5531	5690	5856	6031	6214	6407	6610	6826	7056	7302	7566	7852
23	5092	5234	5380	5533	5693	5859	6034	6217	6410	6614	6830	7060	7306	7571	7857
24	5095	5236	5383	5536	5695	5862	6037	6220	6413	6617	6834	7064	7311	7576	7862
25	5097	5238	5385	5539	5698	5865	6040	6223	6417	6621	6838	7068	7315	7580	7867
26	5099	5241	5388	5541	5701	5868	6043	6226	6420	6624	6841	7072	7319	7585	7872
27	5102	5243	5390	5544	5704	5871	6046	6230	6423	6628	6845	7076	7323	7589	7877
28	5104	5246	5393	5546	5706	5874	6049	6233	6427	6631	6849	7080	7328	7594	7882
29	5106	5248	5395	5549	5709	5876	6052	6236	6430	6635	6853	7084	7332	7599	7887
30	5108	5250	5398	5552	5712	5879	6055	6239	6433	6639	6856	7088	7336	7603	7892
31	5111	5253	5401	5554	5715	5882	6058	6242	6437	6642	6860	7092	7341	7608	7897
32	5113	5255	5403	5557	5717	5885	6061	6245	6440	6646	6864	7096	7345	7612	7902
33	5115	5258	5406	5559	5720	5888	6064	6249	6443	6649	6868	7100	7349	7617	7907
34	5118	5260	5408	5562	5723	5891	6067	6252	6447	6653	6871	7104	7353	7622	7912
35	5120	5263	5411	5565	5725	5894	6070	6255	6450	6656	6875	7108	7358	7626	7917
36	5122	5265	5413	5567	5728	5896	6073	6258	6453	6660	6879	7112	7362	7631	7922
37	5125	5267	5416	5570	5731	5899	6076	6261	6457	6663	6883	7116	7366	7636	7927
38	5127	5270	5418	5573	5734	5902	6079	6264	6460	6667	6886	7120	7371	7640	7932
39	5129	5272	5421	5575	5736	5905	6082	6268	6463	6670	6890	7124	7375	7645	7937
40	5132	5275	5423	5578	5739	5908	6085	6271	6467	6674	6894	7128	7379	7650	7942
41	5134	5277	5426	5580	5742	5911	6088	6274	6470	6677	6898	7132	7384	7654	7948
42	5136	5280	5428	5583	5745	5914	6091	6277	6473	6681	6901	7136	7388	7659	7953
43	5139	5282	5431	5586	5747	5917	6094	6280	6477	6685	6905	7140	7392	7664	7958
44	5141	5284	5433	5588	5750	5919	6097	6283	6480	6688	6909	7145	7397	7668	796[illegible]
45	5143	5287	5436	5591	5753	5922	6100	6287	6483	6692	6913	7149	7401	7673	7968
46	5146	5289	5438	5594	5756	5925	6103	6290	6487	6695	6917	7153	7406	7678	79[illegible]
47	5148	5292	5441	5596	5758	5928	6106	6293	6490	6699	6920	7157	7410	7683	79[illegible]
48	5151	5294	5443	5599	5761	5931	6109	6296	6494	6702	6924	7161	7414	7687	798[illegible]
49	5153	5297	5446	5602	5764	5934	6112	6299	6497	6706	6928	7165	7419	7692	[illegible]
50	5155	5299	5448	5604	5767	5937	6115	6303	6500	6710	6932	7169	7423	7697	[illegible]
51	5158	5301	5451	5607	5770	5940	6118	6306	6504	6713	6936	7173	7427	7702	[illegible]
52	5160	5304	5454	5610	5772	5943	6121	6309	6507	6717	6940	7177	7432	7706	8[illegible]4
53	5162	5306	5456	5612	5775	5946	6124	6312	6511	6720	6943	7181	7436	7711	8[illegible]
54	5165	5309	5459	5615	5778	5948	6127	6315	6514	6724	6947	7185	7441	7716	80[illegible]4
55	5167	5311	5461	5617	5781	5951	6130	6319	6517	6728	6951	7189	7445	7721	8[illegible]
56	5169	5314	5464	5620	5783	5954	6133	6322	6521	6731	6955	7194	744[illegible]	7725	80[illegible]
57	5172	5316	5466	5623	5786	5957	6136	6325	6524	6735	6[illegible]	7198	7454	77[illegible]3	8[illegible]
58	5174	5319	5469	5625	5789	5960	6140	6328	6528	6738	6963	7202	7458	7735	8[illegible]
59	5176	5321	5471	5628	5792	5963	6143	6332	6531	6742	6966	7206	7463	7740	8[illegible]40
′	64°	65°	66°	67°	68°	69°	70°	71°	72°	73°	74°	75°	76°	77°	78°

MERIDIONAL PARTS

′	LATITUDE 49°	50°	51°	52°	53°	54°	55°	56°	57°	58°	59°	60°	61°	62°	63°
0	3382	3474	3569	3665	3764	3865	3968	4074	4183	4294	4409	4527	4649	4775	4905
1	3384	3476	3570	3667	3765	3866	3970	4076	4184	4296	4411	4529	4651	4777	4907
2	3385	3478	3572	3668	3767	3868	3971	4077	4186	4298	4413	4531	4653	4779	4909
3	3387	3479	3574	3670	3769	3870	3973	4079	4188	4300	4415	4533	4655	4781	4912
4	3388	3481	3575	3672	3770	3871	3975	4081	4190	4302	4417	4535	4657	4784	4914
5	3390	3482	3577	3673	3772	3873	3977	4083	4192	4304	4419	4537	4660	4786	4916
6	3391	3484	3578	3675	3774	3875	3978	4085	4194	4306	4421	4539	4662	4788	4918
7	3393	3485	3580	3677	3775	3877	3980	4086	4195	4308	4423	4541	4664	4790	4920
8	3394	3487	3582	3678	3777	3878	3982	4088	4197	4309	4425	4543	4666	4792	4923
9	3396	3488	3583	3680	3779	3880	3984	4090	4199	4311	4427	4545	4668	4794	4925
10	3397	3490	3585	3681	3780	3882	3985	4092	4201	4313	4429	4547	4670	4796	4927
11	3399	3492	3586	3683	3782	3883	3987	4094	4203	4315	4431	4549	4672	4798	4929
12	3400	3493	3588	3685	3784	3885	3989	4095	4205	4317	4433	4551	4674	4801	4931
13	3402	3495	3590	3686	3785	3887	3991	4097	4207	4319	4434	4553	4676	4803	4934
14	3403	3496	3591	3688	3787	3889	3992	4099	4208	4321	4436	4555	4678	4805	4936
15	3405	3498	3593	3690	3789	3890	3994	4101	4210	4323	4438	4557	4680	4807	4938
16	3407	3499	3594	3691	3790	3892	3996	4103	4212	4325	4440	4559	4682	4809	4940
17	3408	3501	3596	3693	3792	3894	3998	4104	4214	4327	4442	4562	4684	4811	4943
18	3410	3503	3598	3695	3794	3895	3999	4106	4216	4328	4444	4564	4687	4814	4945
19	3411	3504	3599	3696	3795	3897	4001	4108	4218	4330	4446	4566	4689	4816	4947
20	3413	3506	3601	3698	3797	3899	4003	4110	4220	4332	4448	4568	4691	4818	4949
21	3414	3507	3602	3699	3799	3901	4005	4112	4221	4334	4450	4570	4693	4820	4951
22	3416	3509	3604	3701	3800	3902	4006	4113	4223	4336	4452	4572	4695	4822	4954
23	3417	3510	3606	3703	3802	3904	4008	4115	4225	4338	4454	4574	4697	4824	4956
24	3419	3512	3607	3704	3804	3906	4010	4117	4227	4340	4456	4576	4699	4826	4958
25	3420	3514	3609	3706	3806	3907	4012	4119	4229	4342	4458	4578	4791	4829	4960
26	3422	3515	3610	3708	3807	3909	4014	4121	4231	4344	4460	4580	4703	4831	4963
27	3423	3517	3612	3709	3809	3911	4015	4122	4232	4346	4462	4582	4705	4833	4965
28	3425	3518	3614	3711	3811	3913	4017	4124	4234	4347	4464	4584	4707	4835	4967
29	3427	3520	3615	3713	3812	3914	4019	4126	4236	4349	4466	4586	4710	4837	4969
30	3428	3521	3617	3714	3814	3916	4021	4128	4238	4351	4468	4588	4712	4839	4972
31	3430	3523	3618	3716	3816	3918	4022	4130	4240	4353	4470	4590	4714	4842	4974
32	3431	3525	3620	3717	3817	3919	4024	4132	4242	4355	4472	4592	4716	4844	4976
33	3433	3526	3622	3719	3819	3921	4026	4133	4244	4357	4474	4594	4718	4846	4978
34	3434	3528	3623	3721	3821	3923	4028	4135	4246	4359	4476	4596	4720	4848	4981
35	3436	3529	3625	3722	3822	3925	4029	4137	4247	4361	4478	4598	4722	4850	4983
36	3437	3531	3626	3724	3824	3926	4031	4139	4249	4363	4480	4600	4724	4852	4985
37	3439	3532	3628	3726	3826	3928	4033	4141	4251	4365	4482	4602	4726	4855	4987
38	3440	3534	3630	3727	3827	3930	4035	4142	4253	4367	4484	4604	4728	4857	4990
39	3442	3536	3631	3729	3829	3932	4037	4144	4255	4369	4486	4606	4731	4859	4992
40	3443	3537	3633	3731	3831	3933	4038	4146	4257	4370	4488	4608	4733	4861	4994
41	3445	3539	3634	3732	3832	3935	4040	4148	4259	4372	4490	4610	4735	4863	4996
42	3447	3540	3636	3734	3834	3937	4042	4150	4260	4374	4492	4612	4737	4865	4999
43	3448	3542	3638	3736	3836	3938	4044	4152	4262	4376	4494	4614	4739	4868	5001
44	3450	3543	3639	3737	3838	3940	4045	4153	4264	4378	4495	4616	4741	4870	5003
45	3451	3545	3641	3739	3839	3942	4047	4155	4266	4380	4497	4618	4743	4872	5005
46	3453	3547	3643	3741	3841	3944	4049	4157	4268	4382	4499	4620	4745	4874	5008
47	3454	3548	3644	3742	3843	3945	4051	4159	4270	4384	4501	4623	4747	4876	5010
48	3456	3550	3646	3744	3844	3947	4052	4161	4272	4386	4503	4625	4750	4879	5012
49	3457	3551	3647	3746	3846	3949	4054	4162	4274	4388	4505	4627	4752	4881	5014
50	3459	3553	3649	3747	3848	3951	4056	4164	4275	4390	4507	4629	4754	4883	5017
51	3460	3555	3651	3749	3849	3952	4058	4166	4277	4392	4509	4631	4756	4885	5019
52	3462	3556	3652	3750	3851	3954	4060	4168	4279	4394	4511	4633	4758	4887	5021
53	3464	3558	3654	3752	3853	3956	4061	4170	4281	4396	4513	4635	4760	4890	5023
54	3465	3559	3655	3754	3854	3958	4063	4172	4283	4398	4515	4637	4762	4892	5026
55	3467	3561	3657	3755	3856	3959	4065	4173	4285	4399	4517	4639	4764	4894	5028
56	3468	3562	3659	3757	3858	3961	4067	4175	4287	4401	4519	4641	4766	4896	5030
57	3470	3564	3660	3759	3860	3963	4069	4177	4289	4403	4521	4643	4769	4898	5033
58	3471	3566	3662	3760	3861	3964	4070	4179	4291	4405	4523	4645	4771	4901	5035
59	3473	3567	3664	3762	3863	3966	4072	4181	4292	4407	4525	4647	4773	4903	5037
	49°	50°	51°	52°	53°	54°	55°	56°	57°	58°	59°	60°	61°	62°	63°

MERIDIONAL PARTS

′	64°	65°	66°	67°	68°	69°	70°	71°	72°	73°	74°	75°	76°	77°	78°
0	5039	5179	5324	5474	5631	5795	5966	6146	6335	6534	6746	6970	7210	7467	7745
1	5042	5181	5326	5477	5633	5797	5969	6149	6338	6538	6749	6974	7214	7472	7749
2	5044	5184	5328	5479	5636	5800	5972	6152	6341	6541	6753	6978	7218	7476	7754
3	5046	5186	5331	5482	5639	5803	5975	6155	6345	6545	6757	6982	7222	7481	7759
4	5049	5188	5333	5484	5642	5806	5978	6158	6348	6548	6760	6986	7227	7485	7764
5	5051	5191	5336	5487	5644	5809	5981	6161	6351	6552	6764	6990	7231	7490	7769
6	5053	5193	5338	5489	5647	5811	5984	6164	6354	6555	6768	6994	7235	7494	7774
7	5055	5195	5341	5492	5650	5814	5986	6167	6358	6558	6771	6997	7239	7498	7778
8	5058	5198	5343	5495	5652	5817	5989	6170	6361	6562	6775	7001	7243	7503	7783
9	5060	5200	5346	5497	5655	5820	5992	6173	6364	6565	6779	7005	7247	7507	7788
10	5062	5203	5348	5500	5658	5823	5995	6177	6367	6569	6782	7009	7252	7512	7793
11	5065	5205	5351	5502	5660	5825	5998	6180	6371	6572	6786	7013	7256	7516	7798
12	5067	5207	5353	5505	5663	5828	6001	6183	6374	6576	6790	7017	7260	7521	7803
13	5069	5210	5356	5507	5666	5831	6004	6186	6377	6579	6793	7021	7264	7525	7808
14	5071	5212	5358	5510	5668	5834	6007	6189	6380	6583	6797	7025	7268	7530	7813
15	5074	5214	5361	5513	5671	5837	6010	6192	6384	6586	6801	7029	7273	7535	7817
16	5076	5217	5363	5515	5674	5839	6013	6195	6387	6590	6804	7033	7277	7539	7822
17	5078	5219	5366	5518	5676	5842	6016	6198	6390	6593	6808	7037	7281	7544	7827
18	5081	5222	5368	5520	5679	5845	6019	6201	6394	6597	6812	7041	7285	7548	7832
19	5083	5224	5371	5523	5682	5848	6022	6205	6397	6600	6815	7045	7289	7553	7837
20	5085	5226	5373	5526	5685	5851	6025	6208	6400	6603	6819	7048	7294	7557	7842
21	5088	5229	5376	5528	5687	5854	6028	6211	6403	6607	6823	7052	7298	7562	7847
22	5090	5231	5378	5531	5690	5856	6031	6214	6407	6610	6826	7056	7302	7566	7852
23	5092	5234	5380	5533	5693	5859	6034	6217	6410	6614	6830	7060	7306	7571	7857
24	5095	5236	5383	5536	5695	5862	6037	6220	6413	6617	6834	7064	7311	7576	7862
25	5097	5238	5385	5539	5698	5865	6040	6223	6417	6621	6838	7068	7315	7580	7867
26	5099	5241	5388	5541	5701	5868	6043	6226	6420	6624	6841	7072	7319	7585	7872
27	5102	5243	5390	5544	5704	5871	6046	6230	6423	6628	6845	7076	7323	7589	7877
28	5104	5246	5393	5546	5706	5874	6049	6233	6427	6631	6849	7080	7328	7594	7882
29	5106	5248	5395	5549	5709	5876	6052	6236	6430	6635	6853	7084	7332	7599	7887
30	5108	5250	5398	5552	5712	5879	6055	6239	6433	6639	6856	7088	7336	7603	7892
31	5111	5253	5401	5554	5715	5882	6058	6242	6437	6642	6860	7092	7341	7608	7897
32	5113	5255	5403	5557	5717	5885	6061	6245	6440	6646	6864	7096	7345	7612	7902
33	5115	5258	5406	5559	5720	5888	6064	6249	6443	6649	6868	7100	7349	7617	7907
34	5118	5260	5408	5562	5723	5891	6067	6252	6447	6653	6871	7104	7353	7622	7912
35	5120	5263	5411	5565	5725	5894	6070	6255	6450	6656	6875	7108	7358	7626	7917
36	5122	5265	5413	5567	5728	5896	6073	6258	6453	6660	6879	7112	7362	7631	7922
37	5125	5267	5416	5570	5731	5899	6076	6261	6457	6663	6883	7116	7366	7636	7927
38	5127	5270	5418	5573	5734	5902	6079	6264	6460	6667	6886	7120	7371	7640	7932
39	5129	5272	5421	5575	5736	5905	6082	6268	6463	6670	6890	7124	7375	7645	7937
40	5132	5275	5423	5578	5739	5908	6085	6271	6467	6674	6894	7128	7379	7650	7942
41	5134	5277	5426	5580	5742	5911	6088	6274	6470	6677	6898	7132	7384	7654	7948
42	5136	5280	5428	5583	5745	5914	6091	6277	6473	6681	6901	7136	7388	7659	7953
43	5139	5282	5431	5586	5747	5917	6094	6280	6477	6685	6905	7140	7392	7664	7958
44	5141	5284	5433	5588	5750	5919	6097	6283	6480	6688	6909	7145	7397	7668	7963
45	5143	5287	5436	5591	5753	5922	6100	6287	6483	6692	6913	7149	7401	7673	7968
46	5146	5289	5438	5594	5756	5925	6103	6290	6487	6695	6917	7153	7406	7678	7973
47	5148	5292	5441	5596	5758	5928	6106	6293	6490	6699	6920	7157	7410	7683	7978
48	5151	5294	5443	5599	5761	5931	6109	6296	6494	6702	6924	7161	7414	7687	7983
49	5153	5297	5446	5602	5764	5934	6112	6299	6497	6706	6928	7165	7419	7692	7989
50	5155	5299	5448	5604	5767	5937	6115	6303	6500	6710	6932	7169	7423	7697	7994
51	5158	5301	5451	5607	5770	5940	6118	6306	6504	6713	6936	7173	7427	7702	7999
52	5160	5304	5454	5610	5772	5943	6121	6309	6507	6717	6940	7177	7432	7706	8004
53	5162	5306	5456	5612	5775	5946	6124	6312	6511	6720	6943	7181	7436	7711	8009
54	5165	5309	5459	5615	5778	5948	6127	6315	6514	6724	6947	7185	7441	7716	8014
55	5167	5311	5461	5617	5781	5951	6130	6319	6517	6728	6951	7189	7445	7721	8020
56	5169	5314	5464	5620	5783	5954	6133	6322	6521	6731	6955	7194	7449	7725	8025
57	5172	5316	5466	5623	5786	5957	6136	6325	6524	6735	6959	7198	7454	7730	8030
58	5174	5319	5469	5625	5789	5960	6140	6328	6528	6738	6963	7202	7458	7735	8035
59	5176	5321	5471	5628	5792	5963	6143	6332	6531	6742	6966	7206	7463	7740	8040
′	64°	65°	66°	67°	68°	69°	70°	71°	72°	73°	74°	75°	76°	77°	78°

LATITUDE

FOR FINDING THE DISTANCE OF AN OBJECT,

BY TWO BEARINGS AND THE DISTANCE RUN BETWEEN THEM

Diff. between the Course and 2nd Bearing.	Difference between the Course and the 1st Bearing.																
	Points.																
Points.	2	2½	3	3½	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
3½	1·00																
4	1·00																
4½	0·81	1·23															
5	0·69	1·00	1·45														
5½	0·60	0·85	1·17	1·66													
6	0·54	0·74	1·00	1·35	1·85												
6½	0·49	0·67	0·88	1·14	1·50	2·02											
7	0·46	0·61	0·79	1·00	1·27	1·64	2·17										
7½	0·43	0·57	0·72	0·90	1·11	1·39	1·77	2·30									
8	0·41	0·53	0·67	0·82	1·00	1·22	1·50	1·87	2·41								
8½	0·40	0·51	0·63	0·76	0·92	1·09	1·31	1·58	1·96	2·50							
9	0·39	0·49	0·60	0·72	0·85	1·00	1·18	1·39	1·66	2·03	2·56						
9½	0·38	0·48	0·58	0·69	0·80	0·93	1·08	1·25	1·46	1·72	2·08	2·60					
10	0·38	0·47	0·57	0·66	0·76	0·88	1·00	1·14	1·31	1·51	1·76	2·11	2·61				
10½	0·38	0·47	0·56	0·65	0·74	0·84	0·94	1·06	1·19	1·35	1·55	1·79	2·12	2·60			
11	0·39	0·47	0·56	0·64	0·72	0·81	0·90	1·00	1·11	1·24	1·39	1·57	1·80	2·11	2·56		
11½	0·40	0·48	0·56	0·63	0·71	0·79	0·87	0·95	1·05	1·15	1·27	1·41	1·58	1·79	2·08	2·50	
12	0·41	0·49	0·57	0·64	0·71	0·78	0·85	0·92	1·00	1·08	1·18	1·29	1·41	1·57	1·76	2·03	2·41
12½	0·43	0·51	0·58	0·65	0·71	0·77	0·83	0·90	0·97	1·03	1·11	1·20	1·29	1·41	1·55	1·72	1·96

TRUE DEPRESSION OR DISTANCE OF THE SEA HORIZON

Height	Dep.	Square	Height	Dep.	Square	Height	Dep.	Square	Dep.	Square
1·1ft	1′	1	3293ft	61′	3721	12966ft	121′	14641	181′	32761
3·5	2	4	3403	62	3844	13183	122	14884	182	33124
8·0	3	9	3513	63	3969	13397	123	15129	183	33489
14·2	4	16	3624	64	4096	13615	124	15376	184	33856
22·1	5	25	3740	65	4225	13836	125	15625	185	34225
31·9	6	36	3855	66	4356	14061	126	15876	186	34596
43·3	7	49	3974	67	4489	14282	127	16129	187	34969
56·6	8	64	4093	68	4624	14502	128	16384	188	35344
71·7	9	81	4213	69	4761	14737	129	16641	189	35721
88·5	10	100	4337	70	4900	14970	130	16900	190	36100
107	11	121	4461	71	5041	15197	131	17161	191	36481
127	12	144	4587	72	5184	15429	132	17424	192	36864
149	13	169	4716	73	5329	15664	133	17689	193	37249
173	14	196	4846	74	5476	15901	134	17956	194	37636
199	15	225	4976	75	5625	16139	135	18225	195	38025
226	16	256	5112	76	5776	16380	136	18496	196	38416
256	17	289	5249	77	5929	16622	137	18769	197	38809
287	18	324	5385	78	6084	16866	138	19044	198	39204
319	19	361	5524	79	6241	17111	139	19321	199	39601
354	20	400	5665	80	6400	17362	140	19600	200	40000
390	21	441	5808	81	6561	17608	141	19881	201	40401
428	22	484	5952	82	6724	17860	142	20164	202	40804
468	23	529	6098	83	6889	18111	143	20449	203	41209
510	24	576	6246	84	7056	18366	144	20736	204	41616
550	25	625	6394	85	7225	18622	145	21025	205	42025
598	26	676	6547	86	7396	18878	146	21316	206	42436
645	27	729	6700	87	7569	19140	147	21609	207	42849
694	28	784	6855	88	7744	19401	148	21904	208	43264
744	29	841	7012	89	7921	19664	149	22201	209	43681
797	30	900	7172	90	8100	19930	150	22500	210	44100
850	31	961	7332	91	8281	20197	151	22801	211	44521
906	32	1024	7492	92	8464	20465	152	23104	212	44944
964	33	1089	7656	93	8649	20736	153	23409	213	45369
1023	34	1156	7824	94	8836	21008	154	23716	214	45796
1084	35	1225	7987	95	9025	21282	155	24025	215	46225
1147	36	1296	8158	96	9216	21558	156	24336	216	46656
1211	37	1369	8330	97	9409	21836	157	24649	217	47089
1278	38	1444	8504	98	9604	22115	158	24964	218	47524
1346	39	1521	8678	99	9801	22397	159	25281	219	47961
1416	40	1600	8852	100	10000	22680	160	25600	220	48400
1487	41	1681	9032	101	10201	22964	161	25921	221	48841
1561	42	1764	9210	102	10404	23251	162	26244	222	49284
1636	43	1849	9393	103	10609	23540	163	26569	223	49729
1713	44	1936	9577	104	10816	23830	164	26896	224	50176
1792	45	2025	9760	105	11025	24121	165	27225	225	50625
1872	46	2116	9951	106	11236	24415	166	27556	226	51076
1954	47	2209	10135	107	11449	24711	167	27889	227	51529
2039	48	2304	10325	108	11664	25008	168	28224	228	51984
2124	49	2401	10518	109	11881	25307	169	28561	229	52441
2212	50	2500	10712	110	12100	25608	170	28900	230	52900
2301	51	2601	10908	111	12321	25911	171	29241	231	53361
2393	52	2704	11105	112	12544	26215	172	29584	232	53824
2485	53	2809	11304	113	12769	26521	173	29929	233	54289
2581	54	2916	11506	114	12996	26829	174	30276	234	54756
2677	55	3025	11709	115	13225	27139	175	30625	235	55225
2775	56	3136	11913	116	13456	27451	176	30976	236	55696
2875	57	3249	12120	117	13689	27764	177	31329	237	56169
2977	58	3364	12328	118	13924	28079	178	31684	238	56644
3081	59	3481	12538	119	14161	28396	179	32041	239	57121
3186	60	3600	12749	120	14400	28715	180	32400	240	57600

TABLE 9

Nº OF FEET SUBTENDING AN ANGLE OF 1′.

Dist. in Miles.	Feet.
1	1·77
2	3·54
3	5·31
4	7·08
5	8·84
6	10·61
7	12·38
8	14·15
9	15·92
10	17·69
11	19·46
12	21·23
13	23·00
14	24·77
15	26·53
16	28·30
17	30·07
18	31·84
19	33·61
20	35·38
21	37·15
22	38·92
23	40·69
24	42·46
25	44·23
26	46·00
27	47·76
28	49·53
29	51·30
30	53·07

INDEX TO MARITIME POSITIONS.

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MARITIME POSITIONS

LATITUDES AND LONGITUDES

OF THE

OBSERVATORIES AND SECONDARY MERIDIANS,

THE PRINCIPAL

HEADLANDS, PORTS, ANCHORAGES, ISLANDS, AND MOUNTAINS IN THE WORLD.

(1)	Places	Lat. N	Lon.
	BRITISH ISLES.		
			West
	GREENWICH OBSERVATORY, ⚓ 1ʰ	51° 28'·6	0° 0'
	St. Paul's Cathedral	51 30·8	0 5·7
			East
	Greenhithe, ferry	51 27·2	0 16·7
	Sheerness, fl. st.	51 26·8	0 44·7
	Chatham Dk. yd., King's stairs	51 23·8	0 35·0
	Margate, ⚓ $^{12}_{0}$, lt. F 85f. N Ch.	51 23·4	1 23·2
	North Foreland, lt. F occ. 188f.	51 22·5	1 26·7
	Ramsgate, ⚓ $^{18}_{6}$, S pier lt. Fr...	51 19·7	1 25·5
	Sandown Castle, centre	51 14·3	1 24·2
	Deal, Telegraph Tower, ⚓ 1ʰ...	51 23·3	1 24·2
	ENGLAND, South Coast.		
⊕ England, S. Coast	S. Foreland, 2 lts. S78°W 134°f., Fl. (electric) 374f., 290f.	51 8·4	1 22·5
⊕ England, S. Coast	Dover, ⚓ $^{18}_{0}$, Castle	51 7·8	1 19·5
⊕ England, S. Coast	Folkestone, ⚓ $^{14}_{0}$, (lt. Fr or fl. [illegible]f.), Ch.	51 4·8	1 11·0
⊕ England, S. Coast	Dungeness, lt. F 107f.	50 55·0	0 58·2
⊕ England, S. Coast	Varne shl., lt. v. W-d 16, R 20ˢ, 30f.	50 56·2	1 16·2
⊕ England, S. Coast	Ridge shl., S pt. [illegible]	50 49	1 17
⊕ England, S. Coast	Rye, ⚓ $^{17}_{0}$, Church	50 57·0	0 43·5
⊕ England, S. Coast	Hastings, 2 lights, 400f., F 60f	50 51·5	0 36·0
⊕ England, S. Coast	Beachy Hd., lt. Fl. 285f.	50 44·4	0 12·7
⊕ England, S. Coast	Newhaven, ⚓ $^{19}_{0}$, W pier lt. F 41f.	50 46·9	0 3·5
⊕ England, S. Coast			West
⊕ England, S. Coast	Brighton, pier lt Fs 35f.	50 49	0 8
⊕ England, S. Coast	Shoreham, ⚓ $^{16}_{0}$, 2 lts. N1°E 750f., F 42f., F 23f, nf.	50 49·8	0 14·7
⊕ England, S. Coast	Selsea Bill, high ho.	50 43·8	0 48·5
⊕ England, S. Coast	Chichester, ⚓ $^{18}_{3}$, Ch	50 50·2	0 46·7
⊕ England, S. Coast	Portsmouth, ⚓, R. N. Coll., OBSERVATORY, ⚓ 1ʰ	50 48·0	1 6
⊕ England, S. Coast	Southampton, St Mich. spire	50 54·0	1 24·2
⊕ England, S. Coast	Hurst, 2 lts. N38°E 750f., F 76f.	50 42·4	1 32·7
I. of Wight	Cowes Castle	50 46·0	1 17·7
I. of Wight	St Catherine's Pt., lt. Fl. (electric) 178f.	50 34·5	1 17·7
I. of Wight	Needles lt. Occ. 80f.	50 39·7	1 35·5
	Christchurch, ⚓ $^{n}_{0}$, N entr.	50 43·9	1 44·2
	Poole, ⚓ $^{15}_{0}$, Branksea Castle	50 41·7	1 58·0
	St. Alban's Hd.	50 35	2 3
	Weymouth, ⚓ $^{12}_{6}$, lt. Fr 23f.	50 36·6	2 26·7
	Portland, 2 lts. N53°W 1509f., F 210f., 136f.	50 31·2	2 27·5

(2)	Places	Lat. N	Lon. W
	Bridport, ⚓ entr.	50° 42'·7	2° 44'·5
	Exmouth, ⚓ $^{20}_{6}$, lt F 100f.	50 37	3 23
	Torquay, lt. Fr 15f.	50 28	3 30
	Berry Hd., fl. st.	50 24	3 28
	Dartmouth, ⚓, 3 lts. F	50 21	3 33
	Start Pt., lt. Fl 1ᵐ 204f.	50 13·4	3 38·5
	Prawle Pt.	50 12	3 43
	Salcombe, ⚓ $^{23}_{4}$, Fort Charles	50 19·3	3 48·0
	Bolt Hd., 430f., fl. st.	50 13·2	3 48·7
⊕ England, S. Coast	Eddystone lt. Fl. 72f.	50 10·9	4 16·0
⊕ England, S. Coast	Plymouth, ⚓, Mt. Wise, fl. st.	50 22·0	4 10·2
⊕ England, S. Coast	——brkw., W end, lt. Occ., bell	50 20·3	4 9·5
⊕ England, S. Coast	Rame Hd.	50 19	4 13
⊕ England, S. Coast	Looe Id., sum.	50 26	4 27
⊕ England, S. Coast	Fowey, ⚓, Castle	50 19·7	4 38·7
⊕ England, S. Coast	Gribbin's Hd., beac. 324f.	50 19·1	4 40·2
⊕ England, S. Coast	Dodman, 379f.	50 13	4 48
⊕ England, S. Coast	Gerran, spire	50 10·7	4 58·7
⊕ England, S. Coast	Falmouth, ⚓, Pendennis Castle	50 8·8	5 2·7
	—— St Anthony, lt. R 20ˢ 65f.	50 8·3	5 1·0
	Black Hd., fl. st.	50 0·4	5 6·5
	Manacles, sum.	50 2·6	5 2·7
	Lizard, 2 lts., F N72°E, 230f.	49 57·7	5 12·0
	St. Michael's Mt.	50 7·0	5 28·5
	Penzance, ⚓. lt pier, Fr at ref.	50 7·1	5 31·5
	St. Leven's Pt., fl st.	50 2·3	5 40·7
	Rundlestone beacon	50 1·1	5 40·2
	Wolf rk., lt. R	49 56·7	5 48·2
	Longship's lt. Int. 88f.	50 4·1	5 44·7
Scilly	St. Agnes, lt. R 1ᵐ 138f.	49 53·6	6 20·7
Scilly	St. Martin's, Day Mk.	49 58·0	6 16·0
Scilly	St. Mary's, fl. st.	49 55·0	6 19·0
Scilly	Bishop rk., lt. Fl 110[illegible]f.	49 52·4	6 26·7
	West Coast.		
	C. Cornwall	50 7·7	5 42·5
	St Ives, ⚓, Steeple	50 12·8	5 26·5
	Godrevy Id., T, sum	50 14·6	5 24·0
	St. Agnes, beac. 621f.	50 18·5	5 13·0
	Trevose Hd., lt. Occ. 204f.	50 33	5 2
⊕ England, W. Coast	Padstow, ⚓, Ch.	50 32·5	4 56·0
⊕ England, W. Coast	Pentire Pt.	50 35·4	4 55·7
⊕ England, W. Coast	Tintagel, Ch.	50 39·8	4 45·5
⊕ England, W. Coast	Hartland Pt., ⊥, 330f., lt. Fl.	51 1·4	4 31·5
⊕ England, W. Coast	Lundy I., [illegible] 2½m., 2 lts. R 2ᵐ 540f., F 470f.	51 10·1	4 40·2
⊕ England, W. Coast	Bideford, ⚓, or Braunton, lts. S70°E 933f., Occ. 93f., 44f.	51 4·5	4 12·0
⊕ England, W. Coast	Mort Pt.	51 11·4	4 13·7
⊕ England, W. Coast	Ilfracombe, ⚓ $^{20}_{0}$, lt. Fr 127f.	51 12·8	4 7·0
	Bridgewater ⚓ or Burnham, 2 lts. S70°W 1500f., Occ. F 23f.	51 15·0	3 0·0
	Flatholm I., S pt., lt. Occ. 136f.	51 22·6	3 7·0

For Index to Maritime Positions, see p. 540.

MARITIME POSITIONS

Region	(3) Places	Lat. N	Lon. W
⊕ Coast of Wales	Great Hangman Hill, 1160f.	51° 13′	3° 59′
	Bristol, ⊞, Cathedral	51 26·8	2 35·5
	Newport, ⊞, Usk lt. F 39f.	51 32·4	2 59·7
	Cardiff, ⊞, Custom ho	51 28·6	3 10·0
	Nash Pt., 2 lts. N8°W, F 182f.	51 24·0	3 33·0
	Mumbles, lt. F 114f.	51 34·0	3 58·2
	Swansea, ⊞, pier lt. F 35f.	51 37·0	3 56·0
	Worms Hd., ⊥, 164f.	51 34	4 20
	Pembrey, ⊞, lt. F 35f.	51 40·7	4 15·0
	Caldy I., 1¼m., S pt., lt. F 210f.	51 37·9	4 41·0
	St. Govan's Hd., 142f.	51 35·8	4 55·5
	St. Ann's lts. N41°W 610f., 2F 192f., 159f.	51 41·0	5 10·5
	Milford, ⊞, Ch.	51 42·7	5 1·5
	Pembroke Dk. yd., NW corner	51 41·8	4 57·2
	Smalls rks., NS 2e., lt. Int. 125f.	51 43·3	5 40·0
	Grasholm I., 3e., sum. 146f.	51 43·9	5 28·7
	Ramsey I., NS 1½m., sum. 444f.	51 51·7	5 20·7
	South Bishop rk., lt. R 144f.	51 51·4	5 24·5
	St. David's Cath.	51 52·9	5 16·0
	Strumble Hd	52 1·7	5 3·5
	Precelly Top, 1754f.	51 56·8	4 46·2
	Cardigan I., 4c., sum. 195f.	52 7·9	4 41·5
	——— Steeple	52 5·2	4 39·5
	Aberystwith, ⊞, lt. F, Castle	52 24·9	4 5·2
	Cader Idris, 3549f.	52 42·0	3 54·5
	Snowdon, 3580f.	53 4·1	4 4·5
	Bardsey I. 1½m., lt. Occ. 129f.	52 45·0	4 48·0
	Caernarvon, ⊞, lt. F 50f.	53 8·5	4 24·7
	S. Stack lt. R 1½m 197f.	53 18·3	4 42·0
	Holyhead, ⊞, lt. F 20f., bell	53 20·0	4 37·0
	Skerries, 1½m., lts. Int. 117f.	53 25·3	4 36·5
	Pt. Lynus, lt. Occ. 128f.	53 25·0	4 17·2
	Beaumaris, ⊞	53 15·9	4 5·2
⊕ England, W. Coast	Great Orme's Hd., lt. F 325f.	53 20·0	3 51·2
	Hoylake, lt. F 31f.	53 23·7	3 11·0
	Bidston, lt. F 228f.	53 24·1	3 4·7
	Leasowe, lt. F 94f.	53 24·9	3 7·7
	Black rk., lt. R 77f.	53 26·7	3 2·7
	Liverpool, ⊞, St. Paul's Ch.	53 24·6	2 59·5
	—— Observatory, ♦ 1h	53 24·8	3 0·0
	Crosby, lt. F 95f.	53 31·4	3 3·5
	Formby SE mark	53 32·3	3 4·0
	Rossell sea mark	53 55·2	3 3·0
	Wyre, lt. F 30f., bell	53 57·3	3 1·7
	Fleetwood, ⊞, lt. F 90f. NW extr.	53 55·6	3 1·0
	Lancaster, Castle	54 3·0	2 48·2
	Walney I., 7m., S pt., lt. R 70f.	54 2·9	3 10·5
	Black Comb, 1919f.	54 15·5	3 19·5
⊕ I. of Man	S. pt., Calf of Man	54 3·2	4 50·0
	Castleton, lt. F 22f.	54 4·4	4 39·0
	Douglas, lt. F 104f.	54 9·0	4 28·0
	N. pt., Ayre Pt., lt. R 106f.	54 25·0	4 22·0
	Peel, lt. F 27f.	54 13·6	4 42·0
	St. Bees Hd., lt. Occ. 333f.	54 30·8	3 38·0
	Whitehaven, ⊞, lt. R 52f.	54 33·2	3 35·7
	Harrington, ⊞, pier lt. F 41f.	54 36·7	3 34·2
	Workington, ⊞, lt. F 42f.	54 38·9	3 34·5
	Maryport, ⊞, S pier, F 52f.	54 43·0	3 30·5
	Carlisle, Cathedral	54 53·8	2 56·0
	Annan, Church	54 59·2	3 15·5

Region	(4) Places	Lat. N	Lon. W
	Southerness	54° 52′·4	3° 35′·5
	Ross I., Fl. 175f.	54 46	4 5
	Burrow Hd.	54 41	4 23
	Mull of Galloway, lt. Int. 325f.	54 38·1	4 51·2
	Port Patrick, ⊞, lt. F 38f.	54 50·3	5 6·7
	Corsewall Pt., lt. R 112f.	55 0·5	5 9·5
	Lough Ryan, ⊞, lt. F 46f.	54 58·5	5 1·7
	Stranraer, ⊞, Church	54 54·5	5 2·0
	Ayr, ⊞, 3 lts. S84°E 850f., F 33f., F 8f.	55 28	4 38
	SCOTLAND, West Coast.		
⊕ W. Coast of Scotland	Ailsa Craig, 1098f., lt. Fl. 60f.	55 15·2	5 7·0
	Pladda, lts. 2F 130f., 77f.	55 25·6	5 7·0
	Ardrossan, ⊞, lt. Fl. 25f.	55 38·7	4 50·5
	Irvine, ⊞, Ch.	55 36·8	4 39·7
	Cumbrae, lt. F 115f.	55 43	4 57·8
	Greenock, ⊞, spire	55 56·9	4 45·2
	Port Glasgow, ⊞, basin	55 56·2	4 41
	Glasgow, new bridge	55 51·9	4 16
	—— Observatory	55 52·7	4 17·7
	Campbelton, ⊞, lt. F 18f.	55 25·0	5 35·5
	Mull of Cantire, lt. F 297f.	55 18	5 48
	Ben Tuirck, 1516f.	55 34	5 34
	Mael Na Ho, Dun Ard	55 35	6 18
	Rhynns of Isla lt. on Oersa I. Fl. 150f.	55 40	6 31
	Colonsay I., 6m., N pt.	56 8	6 9
	Oban, ⊞, Church	56 24·5	5 28
	Lismore I., 9m., lt. F 103f.	56 27·5	5 36
	Fort William	56 48	5 5
	Ben Nevis, 4368f.	56 48	5 0
	Dubh Artach rk.	56 8	6 38
	Iona I., 3 m., W pt.	56 18·7	6 26·7
	I. of Mull, Caliack Pt.	56 36·4	6 19
	Ben More, 3168f.	56 25·5	6 0·7
	Skerryvore rks., lt. R 150 f.	56 19·4	7 7
	Tirey I., 11m., S extr.	56 26	6 55
	Dubh Sgeir rk.	56 31·5	7 2·7
	Coll. I., 10m., N & E pt., rks.	56 41·5	6 27
	Muke Id., Innerah Pt.	56 50	6 16·5
	Rum I., NS 7m., S pt.	56 56·2	6 19·5
	——— W pt.	57 0·5	6 27·2
	Canna I., 4m., W pt.	57 3	6 36·5
	Skye I., Neist Pt.	57 25·2	6 47·2
	—— Dunveggan Hd.	57 30·8	6 43
	Fladdachuan Islet, N end	57 41·8	6 26·5
	Skeir Graitich	57 47·1	6 28
	Ru Hunish	57 42·5	6 21
	Ru Rea	57 51·6	5 48·7
	Ru Coygach	58 6·5	5 26
	Ru Stoer	58 16	5 22
⊕ N. Coast of Scotland	Handa I., [1¼m], 400f. sum.	58 23·0	5 11·7
	Bulgie I., [¼m.], 146f.	58 32·7	5 7
	C. Wrath lt. R 400f.	58 37·5	4 59·7
	Far-out Hd.	58 36·2	4 45·0
	Roan I., 1¼m., mid.	58 33·3	4 19·2
	Strathy Hd.	58 36·0	4 9·5
	Thurso	58 33	3 31
	Holburn Hd.	58 35	3 31
	Dunnet Hd., lt. F 346f.	58 40·4	3 21·2
	Dunensby Hd.	58 39	3 1
	Pentland Skerries, 1½m., lts. N pt., 2F 140f., 170f.	58 41·2	2 55·0

MARITIME POSITIONS

	(5) Places	Lat. N	Lon. W
	Hebrides.		
⊕ Hebrides	Barra Hd., lt. Int. 683f.	56° 47′·1	7° 39′·2
	Barra I., N pt. of Fiaray	57 4	7 26·7
	Eriskay I., NS 3m., S end	57 3	7 17·5
	S. Uist I., NS 17m., E pt., Ushinish, lt. Occ. 176f.	57 18	7 11·5
	—— Ru ard Vula, W pt	57 14·5	7 27·5
	Monach Is., EW 4m. lt. Fl 150f.	57 31·6	7 41·7
	Haskier Is., N Loch, 120f.	57 42·3	7 40·7
	N. Uist I., EW 15m., W pt.	57 36·2	7 33
	Berneray I., 4/4 3m., N pt.	57 44	7 11·5
	Pabbay I., EW 2m., S pt.	57 45·3	7 14·5
	Scalpay, Glas I. EW 2½m., lt. F 130f.	57 51·4	6 38·2
	Shiant Is., 1m., NW one, W end	57 54·5	6 23
	Stornaway, lt. R 56f.	58 11·5	6 22·2
	Chicken Hd.	58 10·8	6 15
	Tiumpan Hd.	58 15·7	6 8
	Butt of Lewis, lt. F 170f.	58 30·8	6 15·7
	Gallon Hd.	58 14·6	7 1·5
	Scarpa I., W pt.	58 1·7	7 10
	Rona I., SE sum. 360f.	59 7·0	5 48·5
	Sulisker I., S sum	59 5·4	6 8·7
	Flannen Is., Rodorheim	58 17	7 39
	St. Kilda, pk. 1220f.	57 49·0	8 34·7
	Rockal [2c.], (a rk N73°E, 1·7m.)	57 36·3	13 41·5
	Orkneys.		
⊕ Orkney Is.	Old Hd.	58 44·3	2 55·5
	Kirkness	58 48·2	2 54·5
	Grimness Hd.	58 49·4	2 52·2
	Burra Ness	58 51·4	2 51·0
	Roseness	58 52·5	2 49·5
	Mull Hd.	58 58·6	2 42·0
	Kirkwall, pier lt. F 31f.	58 59·2	2 57·5
	Brough of Birsa, ⅓m.	59 8·2	3 20·0
	Stromness, ⚓ 16, Church	58 57·8	3 17·5
	Copinsha I., 4/4 1m., mid.	58 54	2 40
	Auskery I	59 2	2 34
	Stronsa I., 4/4 7m., Lamb Hd.	59 4·9	2 32·0
	Sanday I., 4/4 11m., Tresness	59 13	2 28·5
	Start lt. F^r 80f.	59 16·7	2 22·5
	N. Ronaldsha I., 2/2 3m., lt. F 140f.	59 23·4	2 23·7
	——— Stromness, or S pt	59 20	2 26
	Runebrake shl.	59 21	2 37
	Moul Hd.	59 23·0	2 53
	Noup Hd.	59 20·0	3 4·0
	Sacquoy Hd.	59 12·0	3 4·2
	Stour Roray	58 52·4	3 25·5
	S. pt., or Brimms	58 46·4	3 13·5
	Shetlands.		
Shetland Is.	Fair I., 2/2 2m., *h*, T, pk. 711f.	59 33	1 37·7
	Sumburgh Hd., lt. F 300f.	59 51·3	1 17·0
	Mousa I., 4/4 1½m., sum.	60 0	1 11
	Bard Hd.	60 6·1	1 4·5
	Lerwick, ⊞, fort	60 9·4	1 8·7
	Noss Hd., 557f.	60 8·3	1 0·5
	Halsey I., 4/4 5m., S sum. 376f.	60 20	1 0
	Out Skerries, lt. R 145f.	60 25·4	0 44·5
	Barra Voe Ness	60 29·5	1 2·0

	(6) Places	Lat. N	Lon. W
Shetland Is.	Fetlar I., 6/6 6m., E pt.	60 35′·2	0° 46′·0
	Balta I., NS 1⅓m., S pt.	60 44·4	0 47·7
	N. extr. outer Stack rk.	60 51·5	0 52·5
	Gloup Holm, 3c., sum.	60 44·2	1 6·5
	Uya, or NE pt.	60 37	1 26
	Roeness Hill, 1476f W end	60 32	1 27
	Ossa Skerry, rks. 4/4 4c.	60 33·0	1 35·5
	Esha Ness Skerry	60 28·5	1 37·2
	Fugloe Skerry	60 20·4	1 45·0
	Ve Skerries, 2/2 1m., mid.	60 22·5	1 49
	Skelda Ness	60 8·8	1 28·0
	Fitfull Hd., 929f.	59 54	1 24
	Foula I., 4/4 3m., ⌐, sum. 1369f.	60 8·5	2 5·5
	Faero Islands.		
Faero Is.	Monk rk., 30f.	61 23	6 45·7
	Suderoe I., 2/12 5 l., S pt.	61 26·5	6 48·5
	Grt. Diamond	61 43	6 49
	Myggenoes I., EW 4m., W extr. ○	62 8	7 37
	Fugloe I., NS 2½m., E pt. ○	62 20	6 13
	Nalsoe I., 2/12 5m., S pt.	61 58·5	6 39
	Thorshavn, lt. F 35f.	62 2·5	6 45·2
	Haldervig Church	62 18·3	7 2
	SCOTLAND, East Coast.		
⊕ Scotland, E. Coast	Noss Hd., 577f., lt. R 175f.	58 28·6	3 3
	Ord of Caithness, needle	58 10·2	2 31·0
	Tain, ⚓ 26/12, spire	57 48·7	4 3·2
	Tarbetness, lt. Int. 175f.	57 51·9	3 46·5
	Cromarty, ⊞, spire	57 40·7	4 0·0
	Cromarty Pt., lt. F^r 60f.	57 41·0	4 2·0
	Fort George	57 35·1	4 4·5
	Chanonry Pt., lt. F 40f.	57 34·5	4 5·5
	Inverness, ⊞, jail	57 28·6	4 13·5
	Burgh Hd.	57 42·1	3 30·0
	Coversea Skerries, lt. R 160f	57 43·4	3 20·2
	Cullen, Castle hill	57 41·4	2 49·5
	Banff, ⚓ n/0, N pier, lt. F^r 28f.	57 40·3	2 31
	Troup Hd., pt.	57 41·7	2 17·2
	Kinnaird's Hd., lt. F^wr 120f.	57 41·9	2 0·2
	Fraserburgh, 2 lts. F^r 20f., 35f	57 41·5	2 0·0
	Rattray Pt.	57 37	1 49
	Peterhead, S ⚓ 11/0, Keith Inch	57 30·1	1 46·0
	Buchanness, lt. Fl. 130f.	57 28·2	1 46·5
	Aberdeen, ⚓ 21/2, Observatory	57 8·9	2 5·7
	Girdleness, 2 lts. F 185/115f.	57 8·5	2 4
	Stonehaven, ⚓ n/0, 2 lts. F^r_w 24/18f.	56 58·0	2 12·7
	Montrose, ⚓ 21/10, Scurdy Ness, lt. Int 124f.	56 42	2 27
	Red Hd., 255f	56 37	2 29
	Arbroath, ⚓, Abbey	56 33·7	2 35·0
	Buddonness, 2 lts. N49°W 1122f., F 103f., 61f.	56 28·1	2 45·0
	Port-on Craig, 2 lts. S88°E 1324f., F 80f. 30f.	56 27	2 49
	Dundee, ⚓, lts. N80°W 390f., 2 F^r 25f.	56 27·6	2 57·7
	Bell rk., lt. R^wt 93f.	56 26·0	2 23·0
	St. Andrews, ⚓, Ch.	56 20·4	2 47·5
	Fifeness, fl. st.	56 16·7	2 35·0
	May I., 4/4 1m., lt. Fl. 240f.	56 11·1	2 33·2
	Leith, ⚓, pier lts. F	55 58·9	3 10·5
	Edinburgh, Obs. Blackford	55 55·5	3 11·0

MARITIME POSITIONS

(7) Places	Lat. N	Lon.
		West
Inch Keith lt. R 220f.	56° 2·0	3° 8·0
N. Berwick, Church	56 3·4	2 43·2
Bass rock	56 4·7	2 38·2
Dunbar, ⊞, Church	55 59·9	2 31·0
ENGLAND. East Coast.		
St. Abb's Hd., lt. Fl. 224f. ...	55 55	2 8
Eyemouth, Church	55 52·3	2 5·5
Berwick, ⊞ $\frac{21}{6}$, spire	55 45·8	1 59·0
Holy I., Castle	55 40·2	1 47·0
Farn Is., 2 lts. N36°W 560ft., R 30°, 87f., Fl. 45f.	55 37·0	1 39·2
Cheviot hill. 2658f.	55 29	2 9
N. Sunderland Pt., mill.........	55 34·7	1 38·2
Coquet I., lt. F 83f.	55 20·1	1 32·0
Blyth, ⊞$^{n}_{0}$, 2 lts. F..................	55 7·5	1 30·0
Tynemouth, lt. R 154f., Castle	55 1·3	1 25·0
N. Shields, ⊞, Ch................	55 0·7	1 26·7
Newcastle, bridge, N end	54 58·7	1 35·5
Sunderland, ⊞, Church..........	54 54·5	1 21·5
Hartlepool, ⊞ $\frac{15}{5}$, Church	54 41·8	1 10·7
Seaton, ⊥, 2 lts., high lt. F 89f.	54 40·3	1 12·2
Tees River, entrance	54 37·1	1 8·7
Stockton, Church	54 34·0	1 18·7
Redcar, Church	54 36·9	1 3·5
Whitby, ⊞, 2 lts. F 240f.......	54 28·7	0 34·2
Scarborough, ⊞$^{n}_{00}$, lt. F^{r} 58f....	54 17·0	0 23·5
Flamborough Head, lt. R^{2wr} 214f.	54 7·0	0 5·0
Bridlington Quay, Mill, ⊞$^{n}_{0}$ ...	54 5·2	0 11·7
Hull, ⊞, citadel	53 44·6	0 20·0
Killingholme, 3 lts. F 68f., outer	53 38·7	0 12
		East
Spurn lts., N66°W, Occ. & F 93f., 54f.	53 34·7	0 7·2
Inner Dowsing, beacon	53 18·4	0 33·2
Smith's Knoll, $\frac{2}{7}$ 7m., s, S pt.	52 48	2 14
Hunstanton Pt., lt. Occ. 109f.	52 57	0 29·7
Cromer, lt. R 274f................	52 55·5	1 19·0
Hasborough, lt. F 136f.	52 49·2	1 32·2
Winterton, lt. F 110f.	52 43·0	1 41·5
Yarmouth, ⊞, spire	52 36·8	1 43·7
Lowestoft, 2 lts. N28W 2490f. Rev. and F 123f., 40f. ...	52 29·2	1 45·5
Southwold, Church..............	52 19·7	1 40·7
Alborough, steeple...............	52 9·2	1 36·0
Orfordness, lt. Int. 91f..........	52 4·8	1 34·5
Orford, steeple	52 5·7	1 32·2
Landguard Fort..................	51 56·3	1 19·2
Harwich, ⊞ $\frac{21}{15}$, lts. F N62°W 680ft., 45f., 27f.	51 55·8	1 16·7
Walton, tower	51 51·8	1 17·2
Maplin, SE pt.. Occ. 36f., bell	51 35	1 3
IRELAND, West Coast.		West
Cape Clear, I. ⚓ 3m., SW point	51 25·3	9 31
Fastnet rk., 92f., lt. R 148f. ...	51 23·3	9 36·2
Crookhaven, ⚓, Nentr. lt. F 67f.	51 28·6	9 42·7
Mizen Hd.	51 27	9 49·5
Sheep Hd.	51 32·5	9 51·2
Bear Haven, ⚓, Bear I., sum. 887f.	51 37·5	9 52·2

(Side labels: ⊕ England, E. Coast)

(8) Places	Lat. N	Lon. W
Hungry Hill, 181f................	51° 41′	9 47·5
Bantry, Ch.	51 40·8	9 27·2
Roancarrig I., lt. F 55f..........	51 39·2	9 44·7
Calf rk.	51 34	10 16
Bull rk., lt. Fl. 271f.	51 35·5	10 18
Cod's Head........................	51 39·7	10 6·2
Scarriff I., summit	51 43·0	10 15·5
Bolus Hd.	51 47	10 20·7
Skelligs, lt. F 175f...............	51 46·2	10 32·7
Bray Hd...........................	51 53	10 26
Valentia, ⊞, Cromwell's Fort, lt. F 54f.	51 56	10 19·2
Great Foze rk.	52 1·2	10 41·2
Tearaght rk., lt. Fl. 275f.	52 4·5	10 40
Grt. Blasket, ⚓ 3m., N pt....	52 6·7	10 31·2
Brandon Hill, 3126f............	52 14	10 15
Tralee Lit. Samphire I., lt. F 56f.	52 16·2	9 52·7
R. Shannon, ⊞, Kerry Hd. ...	52 25·3	9 56·5
Tarbert, lt. F 58f.	52 35·5	9 21·7
Limerick, ⊞, Cathedral.........	52 40	8 37·5
Kilcradan, lt. F^{r} 133f.	52 34·8	9 42·5
Loop Hd., lt. Occ. 277f.	52 33·0	9 56
Ballard Pt., tower	52 44	9 37
Hags Hd...........................	52 57	9 28
Arran Is., Eeragh I., lt. R 115f.	53 9	9 51·5
—— Inisheer I., lt. F 110f. ...	53 2·7	9 31·5
Black Hd.	53 9	9 16
Galway, ⊞, Mutton I., lt. F 33f.	53 15·2	9 3·2
Skird rks., 1m. Skirdmore ...	53 15·3	10 0
Slyne Hd., 2 lts. S18°E 415f., R^{2wr} 115f., F 104f.	53 24·0	10 14·0
Inishark Hd.	53 36	10 18
Clare I., N pt., lt. F 340f. ...	53 49·5	9 59·5
Inishgort, lt. F 36f.......	53 49·5	9 40·2
Westport...........................	53 48	9 31
Newport, ⊞	53 53	9 33
Bills rk.	53 53	10 12·7
Achil Hd., 2222f., pt.	53 58·5	10 15·2
Black rk., lt. R 283f.	54 4·2	10 19·2
Eagle I., 2 lts. N49°E 395f., F 220f..........................	54 17	10 5·5
Erris Hd...........................	54 18·5	10 0
Stag rks., Nst.	54 22	9 47·7
Downpatrick Hd.	55 19·6	9 20·7
Killala, ⊞	54 11	9 13
Ballina, ⊞, spire	54 6·6	9 9·5
Sligo Black rk., lt. F 79f.	54 18	8 37
Innis Murray I., W end	54 25·7	8 40
Ballyshannon, ⊞ $\frac{12}{5}$, Ch.	54 30·2	8 11·7
Donegal, ⊞ $\frac{2}{5}$	54 39·5	8 7
St. John's Pt., Killibegs, lt. F 98f.	54 34·1	8 27·5
Rathlin O'Birne Is., lt. F 116f.	54 33·7	8 50
Dawros Hd., pt..................	54 49·6	8 34·0
Aran I., Rinrawros lt. R 233f.	55 0·9	8 33·7
Stag rks.	55 4·6	8 29·6
Bloody Foreland Hill, 1059f.	55 8·2	8 15·7
North Coast.		
Tory I., ⚓, 2·5m., lt. on N & W pt. Fl. 130	55 16·5	8 15
Horn Hd., E sum. 824f.	55 12·5	7 57·2
Melmore Pt., tower	55 15·2	7 47·2

(Side labels: ⊕ Ireland, W. Coast; ⊕ Ireland, N. W. Coast)

MARITIME POSITIONS

	(9) Places	Lat. N	Lon. W
N. E. of Ireland	Limeburner shl.	55° 18′	7° 48′
	Fanad Pt., lt. Occ. 127f.	55 16·6	7 37·7
	Buncrana, ⚓, Ch.	55 8·1	7 27·2
	Dunaff Hd.	55 17·1	7 32
	Malin Hd., tower	55 22·8	7 22·2
	Innistrahul, lt. R 181f.	55 25·9	7 13·7
	Slieve Sneacht, 2009f.	55 12	7 20
	Innishowen Hd., 2 lts. S62°E 460f., F 67f. & 92f.	55 13·6	6 55·5
	Londonderry ⚓, Cathedral	54 59·6	7 19·5
	Portrush, ⚓ $^{23}_{17}$, pier	55 12·4	6 39·2
	Giant's Causeway, pt.	55 14·7	6 30·7
	Rathlin I., 2 lts. Int. 243f., F 182f.	55 18·2	6 10·2
	Fair Hd., sum. 626f.	55 13·3	6 8·7
	Torr Pt., rk.	55 11·8	6 3·5
	Knocklayd, Mt., 1675f.	55 9·7	6 15·2
	East Coast.		
East Coast of ⊕ Ireland	Maiden rks., 2 lts. N84°W 1920f., F 95f., 82f.	54 55·8	5 44·2
	Black Hd.	54 46·1	5 41·2
	Carrickfergus, ⚓ $^{a}_{0}$	54 43·5	5 48·5
	Belfast, ⚓ $^{12}_{0}$, spire	54 36·4	5 56·2
	Divis, Mt., 1800f.	54 36·7	6 1·0
	Donaghadee, ⚓ $^{22}_{12}$, lt. F 56f.	54 38·7	5 32
	Ardglass, ⚓ $^{28}_{12}$, lt. F	54 15·4	5 36·0
	Downpatrick, ⚓, Cathedral	54 19·6	5 43·0
	St John's Pt., lt. Int. 62f.	54 13·2	5 40
	Slieve Donard, 2796f.	54 10·8	5 55·2
	Carlingford, ⚓ $^{23}_{9}$, lt. R 29f.	54 2·0	6 7·7
	Newry, Church	54 10·6	6 19·7
	Dundalk, ⚓ $^{18}_{2}$, lt. Fl. 33f.	53 58·7	6 17·7
	Clogher Hd., pt	53 47·6	6 13
	Drogheda, ⚓ $^{14}_{2}$, 3 lts F, bridge	53 42·8	6 15
	Balbriggan, ⚓ $^{12}_{0}$, lt. F 42f.	53 36·8	6 10·7
	Rockabil Is, 2 rks., lt. Fl. 148f.	53 35·8	6 0·2
	Lambay I., sum.	53 29·6	6 1·0
	Howth Bailey, lt. F 134f.	53 21·7	6 3·0
	Dublin Observatory	53 23·2	6 20·5
	—— Poolbeg. lt. F 66f.	53 20·5	6 9
	Kingstown, ⚓, E lt. Rʷ 41f.	53 18·1	6 7·7
	Grt. Sugar Loaf, 1651f.	53 9·2	6 9·0
	Wicklow Hd., lt. Occ. 121f.	52 57·9	6 0·0
	Wexford College, tower	52 20·1	6 28·2
	South Coast.		
S.E. of Ireland	Tuskar rk., lt. Rʳʷ 108f.	52 12·1	6 12·5
	Carnsore Pt.	52 10·3	6 21·7
	Hook lt. F 152f.	52 7·4	6 55·7
	Waterford, ⚓ $^{26}_{13}$ bridge	52 16	7 6
	Duncannon fort, 2 lts. F vert. 53f. and 43f.	52 13·2	6 56
	Dunmore, ⚓, pier lt. Fʳ 44f.	52 9	6 59·5
	Brownstown Hd., 102f., 2 tow...	52 7	7 7
	Helwick Hd.	52 3	7 32
	Dungarvan, Ballinacourty Pt., lt. F 52f., w	52 4·5	7 33
	Minehead, lt. Int. 285f.	51 59·5	7 35·2
	Ballycottin I., lt. Fl 195f.	51 49·5	7 59
	Youghal, ⚓, lt. F 78f.	51 56·6	7 50·5
	Roche Pt., 2 lts. Occ. and F 98f., 66f.	51 47·5	8 15·2
	Haulbowline I., tower	51 50·5	8 18·2
	Cork, Custom house	51 53·8	8 27·7

	(10) Places	Lat. N	Lon.
			West
	Barry Hd.	51° 42′·1	8° 23′·2
	Charles Fort, fl. st., lt. F 98f	51 41·8	8 29·7
	Kinsale, ⚓, Old Hd., lt. F 236f.	51 36·2	8 32
	Seven Hds., Telegr.	51 34·2	8 42·7
	Galley Hd., S pt.	51 31·8	8 57·0
	Stags, off Toe Hd., large rk.	51 28·1	9 13·5
	Baltimore, ⚓	51 29	9 22
	EUROPE.		
	BELGIUM.		East
Belgium ⊕	Dunkirk, ⚓, lt. F, Fl. 193f.	51 3·1	2 22·0
	Nieuport, ⚓ $^{n}_{0}$, lt. Fʳ 98f., (NW of town)	51 8·6	2 44
	Ostend, ⚓, 4 lts., E one F 189f.	51 14·3	2 56·2
	Blankenberg, lt. F 83f.	51 19·0	3 7·0
	Heijst, lt. F 26f.	51 20·4	3 14·2
	Flushing, ⚓, lt. F 49f.	51 26·4	3 34
	Middelburg	51 30·0	3 37·0
	Schouwen, W end of I., lt. Fl. 171f.	51 42	3 41
	Bergen op Zoom, Ch.	51 29·7	4 17·5
	Goedereede, lt. on Ch. F 148f.	51 49·2	3 58·5
	Antwerp, ⚓, Cath.	51 13·2	4 24·2
	Helvoetsluys, lt. F 49f.	51 49·2	4 8·0
	Brielle, ⚓, Church	51 54·2	4 10·0
	Rotterdam, ⚓, Cath.	51 55·3	4 29·5
	The Hague, St. James' Ch.	52 4·3	4 18·7
	HOLLAND.		
Holland ⊕	Scheveningen, lt. Rev. 157f.	52 6·3	4 16·5
	Katwyk, Coast lt. F 82f.	52 12·0	4 23·7
	Nordwyk, lt. F 66f.	52 14·6	4 26·0
	Alkmaar	52 37·9	4 45·2
	Zandvort, lt. F 75f.	52 22·3	4 32·0
	Egmont lts, 2F 125f., 120f.	52 37·2	4 37
	Kyk duin, lts. F 187f. and 45f.	52 57·1	4 43·5
	Helder, ⚓	52 57·7	4 45·0
	Texel I., ⚓ $^{2}_{2}$ 11m., W pt.	53 3	4 42
	Medemblik, Ch.	52 46·4	5 6·5
	Marken I., lt F 52f	52 27·6	5 8
	Amsterdam, ⚓, W steeple	52 22·5	4 53·2
	Haarlem, Grt. Ch. tower	52 22·9	4 38·5
	Leyden, Observatory	52 9·5	4 29·5
	Vlieland, lt. F 151f.	53 17·8	5 3·7
	Ter Schelling, lt. R 1ᵐ 177f.	53 21·6	5 13·7
	Ameland, beacon	53 27·0	5 42·0
	Schiermonikoog, 2 lts. F 139f. and 147f.	53 29·3	6 9·0
	Rottum I., beac	53 32·0	6 32·0
	Borcum, lt. F, Fl. 207f.	53 35	6 40
	PRUSSIA.		
Prussia	Emden, Hotel de Ville	53 22·1	7 12·7
	Wangeroog I., *l*, lt. Fl 108f.	53 47·6	7 54
	Bremer or Weser lt. v., fl. F 28f., bell, guns	53 48	8 8
	Bremen, Observatory	53 4·6	8 49·0
	Wilhelmshaven, Observatory	53 31·9	8 8·7
	Heligoland I., lt. F 225f.	54 10·8	7 53·0
	Neuwerk I., lt. F, Fl. 126f.	53 55·2	8 30·0
	Cuxhaven, lt. F, Fl. 70f.	53 52·5	8 42·0
	Gluckstadt, pier lt. Fʳ 30f.	53 47·1	9 24·5

MARITIME POSITIONS

	(11) Places	Lat N	Lon. E
	Altona, Observatory	53°32′7	9°56′5
	Hamburg, OBSERVATORY	53 33 1	9 58 5
	DENMARK.		
Denmark ⊕	Horn Pt., rf., outer shl. ⚓	55 35	7 40
Denmark ⊕	Hantsholmen Pt., lt. R 218f.	57 6 8	8 36 2
Denmark ⊕	Harshals Nist	57 35	9 56
Denmark ⊕	The Skaw, pt., *l*, lt. F 144f.	57 43 8	10 38 5
Denmark ⊕	Hirtsholmen, lt. F, Fl. 95f.	57 29 2	10 37 5
Denmark ⊕	Fladstrand, Church	57 27 0	10 33 7
Denmark ⊕	Nisingen, lts, 2 F 66f., bell	57 18	11 54
Denmark ⊕	Læsø I., ⚓ 10m., Byrum Ch.	57 15 4	11 0 2
Denmark ⊕	Anholt I., E pt., lt. Fl. 133f.	56 44 3	11 39 2
Denmark ⊕	Hesselo, lt. F 118f.	56 11 7	11 43
Denmark ⊕	Aalborg	57 2 7	9 55
Denmark ⊕	Fornas, lt. Fl. 69f.	56 26 7	10 57 5
Denmark ⊕	Aarhus, Cath.	56 9 5	10 13 0
Denmark ⊕	Thunö I., lt. F 100f.	55 56 9	10 27 0
Denmark ⊕	Baago, lt., S pt., F 39f.	55 17 7	9 48 0
Denmark ⊕	Apenrade	55 2 6	9 25 2
Denmark ⊕	Assens, Church	55 16 1	9 53 7
Denmark ⊕	Flensburg	54 46 9	9 26 2
Denmark ⊕	Siœllands rf., N and W pt.	56 5	11 15
Denmark ⊕	Kyholm	55 56 0	10 40 7
Denmark ⊕	Reef ness, lt. F 79f.	55 44 7	10 52 5
Denmark ⊕	Sprogo, lt. R 134f.	55 20	10 58
Denmark ⊕	Nyeborg, Ch.	55 18 7	10 47 7
Denmark ⊕	Fakkeberg, lt. S pt. Langeland, F 129f.	54 44 4	10 42 0
Denmark ⊕	Spotsbierg, lt. Fl. 123f.	55 58 6	11 52 0
Denmark ⊕	Nakkehead, 2 lts. N89° W, F 147f., 98f.	56 7 2	12 21 0
Denmark ⊕	Elsineur, Kronborg, lt. F, Fl. 110f.	56 2 2	12 37 5
Denmark ⊕	COPENHAGEN ⚓, University, OBSERVATORY	55 41 2	12 34 7
Denmark ⊕	Stevns Cape, lt. Fl. 209f.	55 17	12 27
Denmark ⊕	Moen I., E pt., lt. F 82f.	54 57	12 33
Denmark ⊕	Gedser point, lt. F 64f.	54 33 8	11 58 0
Denmark ⊕	Trindelen, shl.	54 30 5	12 4
Bornholm	Eartholms, or Christiansö, lt. N pt., Fl. 94f.	55 19	15 12
Bornholm	Bornholm, N pt.	55 17 7	14 46
Bornholm	— S pt.	54 59	15 5
Bornholm	— Rönne, 2 lts., F 76f., 29f.	55 6	14 42
	PRUSSIA in the Baltic.		
Prussia ⊕	Kiel, OBSERVATORY	54 20 5	10 8 7
Prussia ⊕	Fermom I., Marien, lt. R 94f.	54 29 7	11 14 2
Prussia ⊕	Staberhuk I.	54 24	11 19
Prussia ⊕	Lubeck, St. Mary's Church	53 52 1	10 41 5
Prussia ⊕	Wismar, St. Mary's Church	53 53 5	11 27 7
Prussia ⊕	Warnemunde, lt. F 59f.	54 10 7	12 5 7
Prussia ⊕	Rostock	54 5 5	12 9 0
Prussia ⊕	Dars Hd., pt., 2 lts. F & R 108f. & 41f.	54 28 6	12 30 5
Prussia ⊕	Stralsund	54 18 3	13 5 5
Prussia ⊕	Arkona, lt. F 200f.	54 40 9	13 26 2
Prussia ⊕	Bergen, Church	54 25 5	13 28 0
Prussia ⊕	E pt. of Rugen I.	54 21	13 48
Prussia ⊕	Greitswald, lt. Rev. 154f.	54 15 1	13 55 7
Prussia ⊕	Swinemünde, lt. F 207f.	53 55 0	14 18 0

	(12) Places	Lat N	Lon. E
	Stettin	53°25′1	14°34′0
	Colberg, fort	54 10 8	15 35
	Jershoft, lt. R 165f.	54 32 5	16 33 0
	Hela, lt. R 120f.	54 36 1	18 49 2
	Rixhöft, lt. F 231f.	54 49 9	18 20 5
	Neufahrwasser, lt. F 78f.	54 24 2	18 40 2
	Dantzig, Observatory	54 21 3	18 41 2
	Pillau, ⚓, lt. F 96f.	54 38 4	19 54 0
	Konigsberg, Observatory	54 42 8	20 30 2
	Brüster Ort, lt. R 164f.	54 57 6	19 59 2
	Memel, ⚓, lt. F 98f.	55 42	21 6 2
	RUSSIA.		
Russia ⊕	Libau, ⚓, Pilot's Tower, lt. F, Fl 103f.	56 30 9	21 0
Russia ⊕	Windau, Church	57 23 9	21 34 0
Russia ⊕	Lyser Ort, lt. F 118f.	57 34	21 43
Russia ⊕	Domesness, lt. F, Fl. 64f.	57 48	22 39
Russia ⊕	Runo I., lt. F 210f.	57 48	23 15
Russia ⊕	Riga, ⚓, Cathedral	56 57 0	24 6 5
Russia ⊕	Pernau, Germ. Church	58 23 2	24 30
Russia ⊕	Arensberg	58 15 1	22 30
Russia ⊕	Swalfer Ort, lt. Osel I., S pt., Rev. 114f.	57 54 6	22 4
Russia ⊕	Filsand, W pt. of grt. Id., F 136f.	58 23	21 50
Russia ⊕	Dager Ort, lt. 5m. Ed. of pt., F, Fl. 334f.	58 55	22 13
Russia ⊕	Winkova	59 12	22 18
Russia ⊕	Odensholm, lt. Fl. 115f.	59 18 3	23 23 0
Russia ⊕	Parker Ort, lt. F 147f.	59 23 5	24 3
Russia ⊕	Sourop, lt. F 135f.	59 27 9	24 24
Russia ⊕	Nargen I., lt. N pt., R 126f.	59 36 4	24 32 0
Russia ⊕	Revel, St. Olaus Church	59 26 6	24 47
Russia ⊕	Wolf beacon	59 35	24 48
Russia ⊕	Kokskar, lt. F 106f.	59 42 0	25 3
Russia ⊕	Ekholm, lt. F, Fl. 108f.	59 41	25 49
Russia ⊕	Stoneskar beacon	59 49 5	26 21
Russia ⊕	Rodskar I., lt. Fl 66f.	59 58 2	26 42 0
Russia ⊕	Little Tiouters, W pt.	59 50 0	26 53 0
Russia ⊕	Great Tiouters, E sum	59 51 0	27 14 5
Gulf of Finland	Hogland, ⚓ 6m., N pt. 2 lts. S by W 0 6m., F 384f., 33f. lower	60 6 3	26 58 5
Gulf of Finland	Lavenskar I., N pt.	60 2 3	27 51 0
Gulf of Finland	Peni I., E pt.	60 1 1	28 5 0
Gulf of Finland	Seskar I., NW pt., lt. Fl. 97f.	60 2 1	28 23 5
Gulf of Finland	C. Kolganpia, Church	59 50 0	28 34 7
Gulf of Finland	Dolgoi Noss Pt.	59 54 8	29 0 5
Gulf of Finland	Tolboukin, lt. Rev. 95f.	60 2 0	29 33 0
Gulf of Finland	Kronstadt, ⚓, St. Andrew Ch.	59 59 7	29 46
Gulf of Finland	ST. PETERSBURG, Acad. of Science, OBSERVATORY	59 56 5	30 18 2
Gulf of Finland	POULKOVA, OBSERVATORY	59 46 3	30 19 7
Gulf of Finland	Stirs Pt., lt. F 117f.	60 11 0	29 3
Gulf of Finland	Biorko I., S pt., tower	60 15 7	28 43 2
Gulf of Finland	Grekova rk., beacon	60 11 6	28 42 5
Gulf of Finland	Wiborg	60 42 7	28 46
Gulf of Finland	Aspo beacon	60 17 7	27 13
Gulf of Finland	Nerva tower	60 14 8	27 58 5
Gulf of Finland	Sommars I., lt. Rev. 89f.	60 12 4	27 30 5
Gulf of Finland	Lippu I., beacon	60 14 3	27 3 0
Gulf of Finland	Fredrickshamn	60 34	27 12
Gulf of Finland	Lovisa, ⚓	60 27 0	26 16
Gulf of Finland	Orrengrund, beac. 103f.	60 10 6	26 27 2
Gulf of Finland	Grt. Pellinge, or Glosholm	60 11 2	25 50

MARITIME POSITIONS

	(13) Places	Lat. N	Lon. E
Gulf of Bothnia	Soderskar tow. pilots, lt F, Fl. 124f.	60° 7	25° 26′
	Helsingfors, OBSERVATORY	60 9·7	24 57·2
	Sveaborg	60 8·4	24 59·7
	Renskar, lt. F 164f.	59 56	24 25
	Jussari, pilot's ho.	59 49·7	23 34
	Segelskar, beac.	59 46	23 22
	Hango, lt. F. Fl. 112f.	59 46·0	22 57
	Abo, Observatory	60 27·0	22 17·5
	Uto, lt. F 130f.	59 46·5	21 22
	Bogskar	60 4	20 55
	Lagskar, lt. F 100f.	59 50·5	19 55·2
	Nyhamn, beacon	59 58	19 57
	Hogsten, beacon	60 21	19 25
	Nystad, Enskar, lt. F 152f.	60 43	21 1
	Lökö, beacon	60 56	21 9
	Sabbskar, beacon	61 27·7	21 22
	Bjorneborg	61 29·0	21 48
	Torngrund, beacon	62 13·0	21 20
	Christinestad	62 16·2	21 23
	Storkalle shl., S pt. 8f.	62 45	20 50
	Moikepää, beacon	62 54·0	21 6
	Fallskar, beacon	63 4·0	20 49
	Wasa, Church	63 4·3	21 43
	Korsören, beacon	63 11·8	21 10
	Norrskar, lt. R 105f.	63 14	20 37
	Walsoarne Is., N pt.	63 27	21 6
	Helsingkall, rk, 8f.	63 35	21 53
	Ny Carleby, Church	63 32·0	22 32
	Kejsarsklubb, beacon	63 43	22 34
	Tankar, beacon	63 57·3	22 52
	Gamla Carleby, Xpili, lt. F, Fl. 21f.	63 51	23 1
	Kalla rk., lt. F 58f.	64 20·0	23 27
	Nahkiainen shl., 8f.	64 36	23 54
	Brahestad, Church	64 41·5	24 31
	Carlö I., W lt. F, Fl 101f.	65 2·0	24 34
	Uleaborg, Church	65 1·0	25 30
	Ulkogrunni, beacon	65 24	24 51
	Maloren, lt F 78f.	65 32	23 34
	Torneo	65 50·8	24 10
	SWEDEN.		
	Rodkallen rks., **grt.**, mid. lt. R 84	65 19	22 22
	Pitea	65 19·2	21 30·0
	Stor Rebben, beacon	65 12	21 58
	Bjuroklubb, beacon	64 28	21 35
	Grt. Fjäd räg I, mid. lt. R 101f.	63 48	21 1
	Gadd, lt. on S pt. of Is F 70f.	63 36·0	20 46
	Umea	63 49·5	20 18
	Bonden, beacon	63 26	20 4
	Skagsudde, beacon	63 12·0	19 0
	Hernöklubb, beacon	62 36·0	18 0
	Hernosand, Church	62 37·9	17 57
	Bramo I., N pt., beacon	62 14	17 44
	Hudiksvall	61 43·7	17 7·7
	Hornsudde, pt.	61 37	16 30
	Soderhamn	61 17·7	17 5
	Stor Jungfrun, lt. E pt. F 86f.	61 10	17 21
	Gefle	60 40·3	17 9
	Eggegrund, lt. F 61f.	60 44	17 33
	Orskar, lt. R 120f.	60 31·5	18 23
	Nygrund, 10f.	60 29·5	18 41
	S Quarken, Understen, lt. F 78f.	60 16·2	18 54·5
	Svartklubben, lt. R 68f.	60 9·8	18 50

	(14) Places	Lat. N	Lon. E
E. Coast of SWEDEN	Arholma, beacon	59° 51′·0	19° 7′
	Söderarm, lt. R 99f.	59 45·2	19 24
	Svenska Hogarne	59 27	19 31
	Stockholm, ⚓, OBSERVATORY	59 20·6	18 3·5
	Grönskär, lt. F 111f.	59 17	19 2
	Landsort lt. F, Fl. 146f.	58 44·5	17 52
	Enskar, beacon	58 42	17 25
	Hafringe, beacon	58 35	17 19
	Haradskar, beacon	58 8·9	16 59
	Sparo, beacon	57 42·9	16 44
	Westerwyk	57 45·6	16 38
	Kalmar, Church	56 39·5	16 22
	Gottska Sando, W pt.	58 24	19 11
	Faro I., Holm Hd, lt. R 100f.	57 57	19 22
	Gothland, S pt. Hoborg, lt. Rev. 190f.	56 55·2	18 11
	Ostergarnsholm	57 26·5	18 59
	Wisby	57 38·6	18 16
	South Carlso	57 19	17 59
	Oland, N. Hd., lt. F 103f.	57 22	17 6
	— S Hd., lt. F 132f.	56 11·8	16 24
	Christianopel	56 15·5	16 3·0
	Utklippor rks., lt. F, Fl. 100f.	55 56·5	15 42
	Carlscrona, ⚓, lt. F, Fl. 58f.	56 8	15 36
	Carlshamn, 2 lts. F 58f., 17f.	56 10·3	14 52·0
	Hano I., lt. F, Fl. 218f	56 1·0	14 51
	Ahus	55 55·5	14 18
	Cimrishamn, lt. Alt. 30f.	55 33·5	14 22
	Ystad, Church	55 25·8	13 49·5
	Falsterbo, lt. F 78f.	55 23·1	12 49·2
	Malmö, lt. F, Fl. 68f., Ch.	55 37	13 0·0
	Landskrona, 2 lts. F 39f., 48f	55 52·4	12 50·0
	Helsingborg, lt. F 29f.	56 2·7	12 41
	Kullen, lt. Rev. 288f.	56 18·0	12 27·5
	Engelholm, lt. Alt. 13f.	56 16	12 50
W. Coast of SWEDEN	Hallands Wadero, lt. F, Fl. 67f	56 27·1	12 33
	Halmstadt, fort	56 40·4	12 51·7
	Falkenberg, Ch.	56 54·0	12 30·0
	Morup-tange, lt. F 95f.	56 55·2	12 21·7
	Warberg, Castle	57 6·4	12 14·5
	Niddingen, 2 lts., 2 F 66f., bell.	57 18·2	11 54·3
	Vanguard shl., 4	57 32	11 39
	Winga, 2 lts, F, Ft. & F. 87f.	57 38·0	11 36·2
	Buskar, lt. F 82f.	57 38·6	11 40·7
	Gottenburg	57 42·3	11 56·5
	Paternoster Is., lt. Rev. 117f.	57 53·5	11 28
	Hallo, lt. Fl. 128f.	58 20·2	11 14
	Nord Koster, 2 lts. F, Fl. 214f.	58 54	11 0
	NORWAY.		
	Rock, 7f.	58 42	10 53
	Torbjornskar, lt. F, Fl. 84f.	59 0	10 47
	Færder, lt. F 154f.	59 1·7	10 32
	Fulehuk, lt. F, Fl 57f., bell	59 11·5	10 36·2
	Fredriksteen	59 7·5	11 24
NORWAY	Frederikstadt	59 13	10 57
	Christiania, ⚓, new Observ.	59 54·7	10 43·5
	Svenoe Langö Sound, ent.	58 58	9 46
	Tvesteen	58 56	9 57
	Reierskar rk., a gun	58 10·1	8 27
	Jomfrueland, lt. Rev. 144f.	58 52	9 36
	Arendal, Torungen I., lt. 2F 130f.	58 24	8 48
	Oxo, lt. F 139f.	58 4·4	8 4
	Christiansand, 2 ⚓, Ch.	58 9	8 0

MARITIME POSITIONS

(15) Places	Lat. N	Lon. E
Norway		
Flekkero I., ⊞, rks. to S	58° 2′	7° 57′
Ryvingen I., lt. F. Fl. 129f. ...	57 58·0	7 29·5
Naze, lt. F, Fl 163f.	57 58·8	7 3·2
Listerstecn, lt. Fl. 128f........	58 6	6 34
Jedderens, rf. W pt.	58 46	5 24
Tungenes, lt. F 29f.	59 2	5 35
Hvidingso, lt. Occ. 149f.	59 3	5 24
Skudesnæs, lt. F 75f............	59 8	5 18
Hoievarde, lt. F 65f	59 19	5 19
Udsire, 2 lts. N 8° W, 255f F	59 18·3	4 53·5
Sor Haugo rk., lt. F, Fl. 72f....	59 25·2	5 15·2
Bommelöe, S pt..................	59 35	5 11
Fuglöe	60 1	4 59
Lervig, lt. F 47f.	59 47	5 33
Odde, Church.....................	60 4	6 33·2
Kors fiord, I. entr.	60 8	4 57
Bergen, ⊞	60 24	5 18
Blomöe I.	60 32	4 46
Udvær Is., W pt.	62 2	4 28
Aspo I., NW pt.	61 13	4 44
Veragrund	61 17	4 27
Senning skar rk.	61 39	4 35
Stadtland, NW pt................	62 11	5 8
Svinoe.............................	62 20	5 17
Rundo, lt. F 158f...............	62 24·0	5 35·5
Aalesund, Church	62 28·2	6 9
Lepsorev, lt. F 23f.	62 35·5	6 10·5
Molde, Church	62 44·3	7 10
Kvitholm, lt. F, Fl. 128f.......	63 1	7 14
Christiansund, lt. F 65f.	63 7	7 30
Nightingale rks., outer	63 23	7 8
Grip, lt............................	63 14	7 37
Hav flue, rk.	62 51	6 11
Munk Holm, lt. F 38f.	63 27	10 24
Trondhem, Cathedral	63 25·8	10 23·7
Titter Hd.	63 40	8 19
Vigten Is., W extr rks..........	64 46	10 24
——— NW extr. rks.	65 2	10 37
Pæstöe, lt. F 39f................	64 47·4	11 8
Lekoe, sum.	65 5	11 37
Heilhornet, pk.	65 5	12 9
Hoibraken rk.	65 24	11 0
Torghatten Pk.	65 24	12 7
Sola I., sum.	65 40	11 45
Svingleboen rk.	65 38	11 17
Skal svee, rk......................	65 59	11 21
Træn Is., Soholm, lt. Fl. 118f.	66 26	12 0
Hestmando Pk.	66 32	12 50
Kunna, sum.	66 57	13 32
Lofoten Ids., Skomvær, lt. Fl. 159f............................	67 24·2	11 54
Lofoten Pt.........................	67 49·5	12 50
Skraaven, sum. 600f............	68 9	14 44
Trano I., N pt.	68 11·3	15 39
W. Vago I., N pt.	68 20·5	13 59
Lango I., W pt., rks. off.	68 37	14 14
Andoe, N pt.	69 20	16 8
Tromsöe, Observatory	69 39·2	18 57·0
Hvalöe, NW pt..................	70 14·6	19 16
Hammerfest, Meridian pillar...	70 40·1	25 40·5
Vandö, N pt.	70 17·6	19 36
Arnö, NE pt.	70 13	20 49
Soroen I., W pt..................	70 39	21 55
——— N pt., or Tarbalsen ...	70 53	23 19
Rolfso Is., N pt., lt. F 141f....	71 6	23 59
Knivskiero lden Pt.	71 11·0	25 40·0
North Cape...	71 10·3	25 40·0

(16) Places	Lat. N	Lon. E
LAPLAND.		
Lapland		
Svœrbolt Klubb	70° 59′	26° 41′
Nord Kyn	71 6·8	27 41
Vardo I.	70 23	31 7
Rybatschi I., C. Nometski ...	69 58	32 0
Kola, town	68 52·5	33 1
—— R. Kildin I., E pt.	69 19	33 30
RUSSIA.		
White Sea		
Sviatoi Noss., lt F 298f.	68 9·0	39 49·0
C. Orlov, lt. F 222f.	67 11·5	41 22·2
Sosnovets, lt. F 139f.	66 29·5	40 43
Tetrina, vill., Chap.	66 3·9	38 17·5
Konzomen, vill., mid.	66 17·2	36 53·5
C. Touria	66 33	34 28
Kandalaks, Monastery	67 10	32 32
Kyem, Church	64 56·5	34 38·7
Onega, St. Michael Church ...	63 53·6	38 8·5
Jijghinsk I., N pt., lt. F 140f	65 12·3	36 51·5
Arkhangel, ⊞, Trinity Ch. ...	64 32·1	40 33·5
Moudiuga I., lt. Dvina R. F130f.	64 55·8	40 16·2
C. Kerets	65 19·9	39 45
C. Voronov........................	66 31·1	42 19·7
Mezen, Epiphany Ch.	65 50·3	44 17·0
C. Kanushin, near brook	67 11·5	43 48·7
C. Kanin Noss	68 39·2	43 32·5
Kolguyev I., NS 50m., N pt....	69 30	49 20
C. Russian	68 55	54 40
C. Medinsk.	68 58	59 10
Waigatch I., Balvanski Pt. ...	70 29	58 58
Samoyedes Peninsula, C. Vengani	70 45	66 16
— Beli Ostrov I., C. Ivanoff...	73 24	71 35
NOVAYA ZEMLYA.		
C. Menchikoff	70 45	57 42
North Goose Cape...............	72 13	51 50
Suchoi Noss	73 41	53 30
C. Speedwell	74 57	55 35
C. Nassau	70 20	61 39
Orange Is.	77 2	67 43
C. Bismarck	76 19	68 56
Matotchkin Strait, E entr.......	73 8	56 30
Gessen Point	72 10	55 34
FRANCE, North Coast.		
Gravelines lt. F 95f.	51 0·3	2 6·7
Calais, ⊞, F, sf., bell, lt. Fl. (electric) 190f.	50 57·6	1 51·2
C. Grisnez, lt. Fl. (electric) 226f.	50 52·2	1 35·2
Boulogne, ⊞, Column........	50 44·5	1 37·2
Pt. Alpreck, lt. F, Fl. 164f. ...	50 41·9	1 34·0
Etaples, ⊞........................	50 32·9	1 38·7
Pt. de Touquet, 2 lts. F 174f.	50 31·7	1 35·7
Pt. de Berck lt. Occ. 115f	50 24·0	1 33·7
Abbeville, Ch. of Notre Dame	50 7·1	1 50·0
St. Valery sur Somme, ⊞.....	50 11·4	1 38·0
Cayeux, lt. F, Fl. 92f.	50 11·7	1 31·0
Tréport, ⊞, lt. F 44f., sf.	50 3·9	1 22·2
Dieppe, ⊞, W jetty, lt. F 43f., tof.	49 56·0	1 5·2
C. Ailly, lt. R 305f..............	49 55·1	0 57·7

MARITIME POSITIONS

(17) Places	Lat. N	Lon.
France, N. W. Coast ⊕		East
St. Valery en Caux. ⊞, F, Fl. 43f.	49°52′·4	0°42′·7
Fecamp. ⊞, Mt. de la Vierge, F 374f.	49 46·1	0 22·2
C. de la Heve. 2 lts. N19°E 207f., F 396f.	49 30·7	0 4·2
Havre. ⊞. lt. N jetty, bell	49 29·3	0 6·7
Pt. du Hoc, lt. F 39f.	49 28·7	0 11·5
PARIS OBSERVATORY	48 50·2	2 20·2
Quillebœuf, lt. F 33f.	49 28·4	0 31·7
Honfleur, ⊞, lt. F 92f.	49 26	0 14
		West
Mouth of the Orne, Church	49 16·6	0 15·2
Port Corseules, ⊞, lt. F 30f.	49 20·3	0 27·2
Cæn, Abbey	49 11·2	0 21·0
Pt. de Ver, lt. F, Fl. 138f.	49 20·5	0 31·0
Carentan	49 18·4	1 14·5
St. Marcouf Is., $\frac{4}{4}$ $\frac{3}{4}$m., lt. Occ. 56f.	49 29·9	1 8·7
La Hougue, ⊞ $\frac{15}{0}$, lt. F 36f.	49 34·3	1 16·2
Reville Redoubt, lt. F 36f.	49 36·4	1 13·7
C. Barfleur. lt. R 236f.	49 41·8	1 15·7
Pelée I., fort, lt. F 85f.	49 40·3	1 34·7
Cherbourg. ⊞, Ch.	49 38·6	1 37·2
C. La Hague, *l*, lt. F 154f.	49 43·4	1 57·0
Channel Is. ⊕		
Alderney I., $\frac{6}{0}$ 3m., St. Anne Ch.	49 42·9	2 12·2
Pierre au Vraek, rk	49 41·6	2 17·0
Caskets, ┬, lt. Fl. 120f., bell	49 43·4	2 22·5
Guernsey. Jerbourg tow. 390f.	49 25·3	2 33·0
— Pleinmont. SW pt., guard ho	49 25·3	2 41·0
— St. Pierre, lt., S jetty, F 46f.	49 27·0	2 32·0
Herm I., NS 1¼m., mid	49 28·0	2 27·7
Sercq I., $\frac{2}{2}$ 3m., Telegraph	49 25·5	2 22·7
Islet S, or Etat de Sercq	49 23·6	2 23·0
Jersey, St. Pierre, Ch.	49 12·5	2 11·7
— St. Helier's ⊞ $\frac{n}{0}$	49 11·3	2 7·0
— C. Grosnez, ruin	49 15·2	2 15·5
— NE pt., or Pt. de la Coupe	49 13·9	2 2·3
— SE pt., Seymour tower	49 9·4	2 1·1
Roches Douvres, EW 2m. rk., mid.	49 6·5	2 49
Barooue rks., EW 2m.	49 1	2 48
Chausey Is., [6m.], Gt. I., lt. F, Fl. 121f.	48 52·2	1 49·2
Minquiers rks., $\frac{6}{6}$ 5 l., NW breakers	48 59	2 19
Maitresse Id.	48 58·3	2 3·7
France, N. W. Coast ⊕		
St. Germain	49 14·2	1 35·7
C. Carteret, ⊥, lt. R 262f.	49 22·4	1 48·2
Coutances, Cath., 302f.	49 2·9	1 26·5
Granville, ⊞ $\frac{31}{0}$, C. Lihou, lt. F 154f.	48 50·1	1 36·7
Mt. St. Michel	48 38·2	1 30·5
Canalle, Church	48 40·7	1 50·7
Herpin rk.	48 43	1 50
St. Malo, ⊞ $\frac{25}{0}$, Church	48 39·0	2 1·5
La Conchée rk.	48 41	2 3
C. Frehel, ┬, sum., lt. R 259f.	48 41·1	2 19·0
Grand Léjon rk.	48 45·0	2 39·7
St. Brieuc, Cathedral	48 30·9	2 45·7
Horaine rk., beacon	48 53·6	2 55·0
Heaux de Brehat, lt. F 148f.	48 54·5	3 5·0
Treguier, Cathedral	48 47·3	3 13·7
Seven Is., $\frac{6}{0}$ 4m., lt. F. Fl. 184f.	48 52·8	3 30
Triagoz, shl., EW 1m., W extr.	48 53	3 44

(18) Places	Lat. N	Lon. W
Morlaix, ⊞, lt. F 285f.	48°40′	3°53′
St. Pol de Léon, ⊞, Cath.	48 41·0	3 59·0
I. de Bas, EW 3m., lt., W side, Rʷʳ 223f.	48 44·8	4 1·5
I. Vierge, lt. F. Fl. 108f.	48 38·4	4 34·0
Abervrach, W lt. Fʳ 59f.	48 36·9	4 34·5
West Coast.		
Ushant, $\frac{6}{6}$ 4m., lt. Fl. (electric) 272f.	48 28·5	5 4
Kermorvan, lt. F 72f.	48 21·7	4 48
Pt. St. Matthew, lt. R 177f.	48 19·8	4 46·2
Brest, Observatory	48 23·6	4 29·2
I. de Sein. lt. F, Fl. 148f.	48 2·7	4 52·0
Outer, or Wst. rk.	48 3	5 15
Audierne, Church	48 1·4	4 32·5
Penmarc'h rks., lt. R 134f.	47 47·9	4 23
Glenan I., Penfret I., lt. F, Fl. 118f.	47 44	3 57·0
France, W. Coast ⊕		
Quimper Riv., Benodet, Ch.	47 52·6	4 6·7
L'Orient, tower	47 44·7	3 21·0
Port Louis, Church	47 42·5	3 21·0
I. de Groix, $\frac{6}{6}$ 4m., lt. F 193f.	47 38·9	3 30·5
Port Haliguen, lt. E jetty, F 39f.	47 29·2	3 6·0
Teignouse, lt. F, Fl. 59f.	47 27·5	3 2·5
Port Navalo, pt., lt. F 72f.	47 32·9	2 55·0
Penlan Pt., lt. F 68f.	47 31·0	2 30·0
Belle Isle, $\frac{6}{6}$ 10m., lt. Goulfar Bay, R 276f.	47 18·7	3 13·5
— Port de Palais, lt. F 30f.	47 20·9	3 9·0
Hoedic I., $\frac{4}{4}$ 1½m.	47 20·5	2 52·0
Le Four rk., lt. R 79f.	47 17·9	2 38·0
Vannes, St. Peter's	47 39·5	2 45·2
Guérande, Ch., 177f.	47 19·7	2 25·5
Croisic, Church	47 17·7	2 30·7
Aiguillon tow., (on with the tour de Commerce, N32°E)	47 14·6	2 15·7
Port St. Nazaire, Mole, lt. Occ. 26f.	47 16·3	2 11·7
Paimbœuf, Church	47 17·3	2 2·0
Nantes, Cathedral	47 13·1	1 33·0
Le Pilier I., lt. F, Fl. 105f.	47 2·6	2 21·5
Noirmoustier I., S pt.	46 53·8	2 8·7
I. d'Yeu, $\frac{5}{5}$ 5½m., St. Sauveur Church	46 42·4	2 19·7
——— Lt. NW part, F 177f.	46 43·1	2 22·7
St. Gilles sur Vie, Church	46 41·7	1 56·0
Sables d'Olonne, Church	46 29·8	1 47·0
La Chaume, lt. F 105f.	46 29·7	1 47·5
Roche bonne, W, or La Congrée	46 13	2 29
Pt. de Grouin du Cou, lt. F 92f.	46 20·8	1 28·0
Pt. de l'Aiguillon, lt. F 43f.	46 16·1	1 12·5
I. Rhe, $\frac{5}{5}$ 14m., Baleines, lt. on N pt. Fl. 166f.	46 14·7	1 33·5
— Port St. Martin, lt. Fʳ 56f.	46 12·4	1 21·7
— S pt., de Chauveau, lt. F 59f.	46 8·0	1 16·2
Rochelle, 2 lts. F 79f., 46f.	46 9·4	1 9·2
Oleron I., $\frac{4}{4}$ 16m., N pt., Chassiron, lt. F 164f.	46 2·8	1 24·5
Aix I., lt. Fl. 66f.	46 0·6	1 10·5
Rochefort, Hospital	45 56·6	0 57·7

MARITIME POSITIONS

(19) Places	Lat. N	Lon. W
Pt. de la Coubre, lt. F 121f.	45° 41·5	1° 15·2
Cordouan, lt. (Riv. Gironde) Rev. 194f.	45 35·2	1 10·2
Pte. de Grave, lt. Occ. 85f.	45 34·1	1 3·5
Bordeaux, St. André	44 50·3	0 34·5
— Observatory	44 50·3	0 31·2
Bassin d'Arcachon, C. Ferret, lt. F 167f.	44 38·7	1 15·0
Bayonne, Cath.	43 29·5	1 28·5
Pt. St. Martin de Biarritz, lt. Fl. 240f.	43 29·6	1 33·0
St. Jean de Luz, Church	43 23·3	1 39·7
Socoa, lt. F 115f.	43 23·7	1 41·0
SPAIN, North Coast.		
Fuenterabia, Ch.	43 21·7	1 47·2
C. Higuiera, lt. R 197f.	43 23·7	1 48
Port Passage, ⊕, C. La Plata, lt. F 484f.	43 19·7	1 57·2
C. Machichaco, ⊥, lt. F, Fl. 268f.	43 27·0	2 50
C. Villano, ⊥, *h*.	43 27	2 58
Bilbao, St. Nicholas Church	43 15·8	2 54
Portugalete, ⊞	43 20·2	3 3
Mt. Serrantes	43 21	3 5
Santona, ⊕, Caballo Pt., lt. F 85f.	43 28·0	3 27
C. Ajo, pt.	43 31·4	3 36
Santander, ⊕, mole	43 27·9	3 48·7
C. Mayor, E pt., lt. R 298f.	43 30	3 48
Spain, N. Coast ⊕		
C. Oyhambre	43 25	4 21
C. Prieto	43 28·7	4 51·5
Pt. Samos, lt. F, Fl 370f.	43 30·7	5 7·2
C. Lastres	43 34·2	5 18·2
Gijon, lt. F 167f.	43 35·5	5 38
C. Peñas, ⊥, lt. R ¼m 343f	43 42·0	5 49·5
C. Busto, *h*. ⊥, lt. F. Fl. 307f	43 36	6 27·5
Tapia I., lt. F, Fl 77f	43 35·5	6 59·2
Rivadeo, ⊕, I. Pancha, lt. F 79f.	43 34·7	7 2
Mondigo Mt., 1830f.	43 32	7 8
San Ciprian, lt. F 121f.	43 43	7 25·7
Mt. Faro, 1790f.	43 43	7 35
Port Barquero, ⊕, La Estaca, lt. R 306f.	43 47·2	7 41·5
Port Vivero, ⊕, town	43 40·5	7 36
C. Ortegal, *h*, ⊥, tow. (S F 4 or pt.)	43 46	7 54·7
C. Prior, ⊥, lt. F 416f.	43 34·1	8 18·5
Monte Ventoso, 785f.	43 29	8 10
Ferrol, ⊕, mole	43 28·5	8 14·2
Coruña, ⊕, lt. F, Fl. 332f.	43 22·5	8 24·5
Sisargas Is., EW 1½m., lt. F. Fl. 351f.	43 21·5	8 50·2
C. Villano, ⊥, NE pt., lt. F 243f.	43 10	9 13·2
C. Toriñana, ⊥, pt.	43 4	9 18
C. Finisterre, lt. R 466f.	42 53	9 15·5
Quejal Pt., lt. F 88f.	42 41	9 [illegible]
C. Corrobedo, lt. F 106f.	42 34	9 5
Ons I., ⌿ 3m., lt. F. Fl 421f.	42 22·5	8 55·5
Cies Is., NS 4m., lt. F, Fl. 604f	42 12·5	8 54·5
C. Silleiro, *h*, lt. F 72f.	42 6	8 53
Vigo, lt. R 102f.	42 15	8 4[illegible]

(20) Places	Lat. N	Lon. W
Mt. Nossa Señora del alba, 1670f.	42° 10'	8° 43'
Mt. Peneda, 4542f.	41 58	8 21
PORTUGAL.		
R. Mino, Pt. Picos, lt. F 56f.	41 52	8 52
Viana, ⊞, 2 lts. F 107f.	41 41	8 50
Mt. Destrello de Malhada, 3602f.	40 53	8 11
Oporto, ⊞, Fort St. Joas da Foz	41 8·8	8 40·5
Aveiro, New Bar, ⊞	40 39	8 44
Mt. Caramullo, 3274f.	40 32·5	8 12·5
Mount Busaco, 1795f.	40 23	8 22
Coimbra, University	40 12·5	8 25·5
C. Mondego, lt. F 302f.	40 11	8 55
Figueira, ⊞, lt. F 36f.	40 9	8 51·5
Nazareth	39 36	9 5·2
Portugal ⊕		
Burlings, lt. R 365f.	39 25·0	9 30·5
C. Carvoeiro, pt., lt. F 180f.	39 21·8	9 24·2
Monte Junto, 2185f.	39 11	9 3
Mafra	38 56	9 19
C. Roca, lt. Rev 596f.	38 47	9 30
Mt. Cintra, sum. 1600f.	38 46	9 26·5
Da Guia, lt. F 167f.	38 41·8	9 27
St. Julian, fort, lt. F 128f.	38 40·4	9 19·5
Lisbon, ⊞, Marine Obs., ⊞	38 42·2	9 8·5
Royal Observatory	38 42·5	9 11·2
C. Espichel, ⊥, *h*, lt. Fl. 535f.	38 24·9	9 13
Setubal, ⊞	38 32	8 53
C. Sines, *l*, ⊥, lt. F 130f.	37 57·5	8 53
Monchique Mtns., sum Foia, 2959f	37 18	8 34
C. St. Vincent, ⊥, lt. R 221f.	37 1	8 57·7
Sagres Pt., Semaphore	36 59·7	8 55
Lagos, Piedade Pt.	37 4·7	8 38·2
C. Carvoeiro, tower	37 5·2	8 24·7
C. Sta. Maria, *l*, lt. F 109f.	36 58·5	7 49·7
Mt. Figo, 1365f.	37 6	7 48·7
SPAIN, South Coast.		
R. Guadiana, ⊞, Canela I., 2 lts. F 109f., 43f.	37 11·5	7 24
Palos	37 13·5	6 53
Spain, S. Coast		
R. Guadalquiver, San Lucar Lookout	36 46·2	6 21
Rota, pier	36 36·6	6 21·5
Cadiz, ⊕, Observatory	36 32·0	6 17·2
——— S Fernando	36 27·7	6 12·5
St. Sebastian, lt. F, Fl. 146f.	36 31·6	6 19
C. Trafalgar, lt. F, Fl. 168f.	36 10·8	6 2
Tarifa, lt. F 130f.	36 0	5 36·7
Palomos I.	36 3·7	5 20·2
Algeciras, mole	36 7·5	5 26·7
Gibraltar, Dockyard Flagstaff	36 7·3	5 21·5
Europa Pt., lt. F 150f.	36 6·2	5 20·7

MARITIME POSITIONS

(21)	Places	Lat. N	Lon.
	SPAIN.		West
	Torre Nueva	36° 12·3	5° 19·7
	C. Sardinia, tower	36 18·7	5 16
	Doncella, lt. F, Fl. 59f.	36 25	5 9
	Sierra Bermeja, Mt., 4728f.	36 29	5 13
	Fuengiro, Castle	36 33	4 37
	Sierra de Mijas	36 38	4 40
	Malaga, ⊞, mole, lt. F, Fl. 125f.	36 43	4 24
	Velez Malaga, ⚓ II, lt. F 41f.	36 43	4 7
	C. Sacratif, h, ⊥, lt. F, Fl. 320f	36 42	3 28
	Adra, fort, lt. F 55f.	36 44	3 1
	Alboran I., lt. F 115f.	35 58	3 2
	Pt. Sabinel, lt. F, Fl 105f.	36 41·2	2 42
	Almeria, Citadel.	36 50·3	2 28·6
	C. de Gata, lt. R 194f.	36 43	2 11·2
	Port Genoves, ⚓, Castle	36 45	2 6·2
	Pt. Mesa, lt. F, Fl. 725f.	36 56	1 54·5
	Port Aguilas, Castle	37 23·4	1 34·5
	C. de Cope, 823f.	37 25·3	1 28
Spain, E. Coast ⚓	C. Tinoso, h, ⊥, lt. F 480f.	37 32	1 7
	Cartagena, Escombrera I., lt. F. 223f.	37 33·5	0 58
	C. de Palos, lt. R 263f.	37 37·5	0 41
	C. Cervera	38 0	0 40
	I. Plana, E extr. of rks. 6/15 ⊥, F, Fl. 90f.	38 10	0 28
	Alicante, Castle, (lt. Fr 26f.)	38 20·3	0 28·7
	Mt Roldan, gap	38 36	0 12
			East
	C. Nao, E pt.	38 43	0 14
	C. St Antonio, lt. R 571f.	38 48·5	0 12
	Mongó, Mt., 2497f.	38 48	0 8
			West
	C. Cullera, tow., lt. F 91f.	39 11	0 12·7
	Valencia, lt. Fr 39f., mole	39 26·8	0 19
	C. Canet, tower	39 43·0	0 9
			East
	C. Oropesa, lt. F, Fl 74f.	40 4	0 9
	Peñiscola tow.	40 23·0	0 25
	Columbretes Is., lt. F 262f.	39 54	0 42
	Port Alfaques, Pt. de la Baña	40 33·5	0 39
	Ebro R., S passage	40 41·0	0 53
	C. Rock, tower	40 49·0	0 45
	C. Tortosa, Buda, lt. Rev. 174f.	40 42·4	0 54
	C. Salou, pt., lt. F, Fl. 139f.	41 3·0	1 10
	Tarragona, lt. F 54f.	41 7	1 15
	Barcelona, ⊞ n/15, mole lt. F, Fl. 43f.	41 22·6	2 11
	Mt. Jui, fort	41 21·8	2 10
	Mataro	41 32·4	2 27
	C. Tosa, tower	41 43·2	2 58
	Pt. Molino	41 49·6	3 8
	C. St. Sebastian, h sum., lt. F, Fl. 548f.	41 53	3 12
	Medas Is., 4/14 1m., S & E extr.	42 3·2	3 14
	La Escala	42 7	3 8
	C. Norfeo, h, ⊥, E pt.	42 14	3 17
	Cadaqués, ⊞, Church	42 17	3 17
	C. de Creux, lt. F, Fl. 285f.	42 19·2	3 19

(22)	Places	Lat. N	Lon. E
	FRANCE.		
	St. Pedro de Roda, fort	42° 19·0	3° 10′
	C. Sernella	42 21·0	3 13
	C. Bearn, lt. F 751f.	42 31·0	3 7·5
	Port Vendres, lt. Fl. 98f.	42 31·3	3 7·0
	Perpignan	42 43	2 53
	La Nouvelle, lt. F 50f.	43 0·8	3 4·0
	Narbonne, Cathedral	43 11·1	3 0·2
	Fort Brescou, lt SE bast., F 59f.	43 15·5	3 30·0
	Agde, Mt., lt. R 413f.	43 17·9	3 30·2
	Cette, ⊞, Ft. Louis, lt. F 105f.	43 23·8	3 42·2
	Montpelier	43 37	3 53
	Aigues Mortes, lt. F 33f.	43 32·0	4 8·0
	W. Mo. of Rhone, Camargue, 2 lts. F 125f., 38f	43 20·7	4 41·0
	P. de Bouc, ⊞, 2 lts. ent. F 49f., 95f.	43 23·6	4 59·2
	C. Couronne	43 19	5 3
	Marseille, St. Jean Ft., F 30f.	43 17·7	5 21·7
	——— Observatory	43 18·3	5 23·7
	Planier I., lt. Fl. 207f.	43 11·9	5 14·0
France, S. Coast ⊕	Mt. St. Michael, Semaph., 1341f.	43 13	5 22
	I. Riou, E.W 1m., tower	43 10	5 23
	Cassis, ⊞, Port, 2 lts. F 92f., 31f.	43 12·8	5 32·0
	Cassidaigne rk	43 8·7	5 33·0
	Ciotat Port, lt. F 40f.	43 10·3	5 30·7
	Bandol, Church	43 8·2	5 45·5
	C. Sicie, Semaphore	43 3·2	5 51·0
	Toulon, ⊞, Observatory	43 7·5	5 56·0
	Grd. Ribeau, lt. F 112f.	43 1	6 8
	Porquerolles I., 6/15 4m., S pt., lt. F, Fl. 262f.	42 59·0	6 12·5
	Port Cros I., 6/15 2½m., Fort Vigie	42 59·9	6 24·2
	Titan I., 6/15 4½m., NE part, lt. F 246f.	43 2·8	6 30·7
	C. Camarat, lt. R 426f.	43 12·0	6 40·7
	St. Tropez	43 14	6 34
	Frejus, ⚓	43 25	6 46
	C. Roux, ⊥, ⚓, sum. 1600f.	43 28	6 55
	Cannes, S tower	43 32·9	7 1·0
	Lerin Is., EW 2m., S extr. rks.	43 30	7 3
	C. Garoupe, lt. F 338f.	43 33·8	7 8
	Antibes, ⊞ 15, barb. lt. F, Fl. 49f.	43 35·1	7 7·7
	St. Laurent du Var	43 40·7	7 11·0
	Nice, St. Francis Church	43 42·0	7 17·0
	— Observatory, Mont-gros	43 43·3	7 18
	Villa Franca, ⊞	43 42	7 18
	C. Ferrat, lt. Rev. 229f.	43 40·0	7 19·5
	Monaco	43 45·0	7 27·0
	BALEARIC ISLES.		
	Formentera I., 4/15 3m., SE pt., lt. F 450f.	38 39	1 35
	——— S pt., or Pt. Angaila, ⊥	38 38	1 23
	Iviza, Port St. Antonio, ⊞, Conejera I., lt. Rev. 289f.	38 59·4	1 13·0
	– Grosa Pt., lt. Int. 180f.	39 5	1 36
Iviza	Iviza, ⊞, Castle	38 54·3	1 26·7
	Cabrera I., 4/14 3½m., 564f., Pt. Anciola, lt. Rev. 404f.	39 7·2	2 55

MARITIME POSITIONS

	(23) Places	Lat. N	Lon. E
	Majorca, C. Salinas, *l*, ☨, lt. F 50f.	39° 16′	3° 4′
	C. Blanco. ⊥, lt. F 292f.	39 22	2 47
Majorca	Palma, mole, lt. F 35f.	39 34·1	2 38·5
	C. Cala Figuera. T. lt. F 115f.	39 28	2 32
	Dragonera I., ⅓ 2m., lt. F, Fl. 1180f.	39 35	2 19
	Mt. Galatzo, 3363f.	39 39	2 31
	C. Formenton, ⊥, lt. R 592f.	39 58	3 13
	C. Pera, ⊥, lt. F, Fl. 241f.	39 43	3 28·5
	Minorca, C. Dartuch, *l*, T, lt. F, Fl. 71f.	39 55	3 49·5
	C. Bajoli, ⊥, tow. 256f.	40 1	3 48
Minorca	C. Cavalleria, *h*, ⊥. lt. F 309f.	40 5·8	4 5·5
	Mahon, ⚓, lt. F 73f.	39 52·5	4 18·0
	Ayre I., EW ¾m., lt. Rev. 171f	39 48	4 17
	SARDINIA.		
	Razzoli I., lt. F 282f.	41 18·3	9 20·7
	C. della Testa, T, lt. F, Fl. 220f.	41 15	9 9·2
	Port Torres, ⚓, lt. F 47f.	40 50·2	8 24·7
	Asinara I., ⅓ 10m., 1239f.	41 5·8	8 18·2
	C. Falcone, tow. 610f.	40 57·3	8 12·2
	C. Argentera, sum.	40 43·7	8 9·0
	C. Caccia, T, P. Conte, ⚓, sum.	40 33·5	8 10·2
	Alghero, Cathedral	40 33·5	8 19·2
	C. Marargiu, rk.	40 19·7	8 23·5
	C. Mannu, tow. on N pt.	40 2·5	8 24·0
	Mal di ventre, rks. ⅓ 3m., mid.	39 59	8 18
	Coscio di Donna, rk. [½ c.]	39 52·8	8 17·2
	C. St. Marco, tower	39 51·2	8 26·5
	C. Frasca	39 46	8 27
	Oristano, grt. tower	39 54·3	8 31·7
	Mt. Arcuento (or finger of Oristano), 2713f.	39 35·7	8 33·5
	C. Pecora, pt., tow.	39 27·1	8 25·2
	St. Pietro I., NS 5¼m., 702f.	39 9·7	8 17·7
SARDINIA ⊕	St Antioco I., NS 9m., S sum. 781f.	38 58·3	8 26·0
	Toro rk., T, 500f.	38 51·6	8 25·2
	C. Teulada, ⊥, T, sum. 725f	38 51·9	8 39·2
	Port Maltatano, ⚓, tow.	38 53·1	8 48·7
	C. Spartivento, lt. F 264f.	38 52·5	8 52·5
	Cagliari, ẇ, St. Pancras Ch.	39 13·2	9 7·7
	Cavoli I. (off C. Carbonara), tow.	39 6·1	9 31·5
	C. Ferrato, ⊥, 80f. pt.	39 17·5	9 40·0
	Mt. Seven Brothers, 3186f.	39 18·5	9 26·5
	C. Bellavista, lt. F 541f.	39 55·8	9 43·5
	Mt. Gennargentu, 6102f.	40 1	9 19
	C. Comino, pt.	40 31·4	9 50·5
	Limbarra, pk. 4331f.	40 51·0	9 11·0
	Tavolara I., ⅓ 3½m., E pt.	40 54·8	9 45·0
	C. Figari, sum.	40 59·9	9 39·7
	Rock	41 16·9	9 29·0
	Caprera I., NS 5m., sum.	41 12·9	9 29·0
	Madalena I., old fort	41 13·4	9 24·0
	CORSICA.		
	C. Corso, Giraglia I., lt. R 269f.	43 1·8	9 24·2
	St Fiorenza, centre of town	42 41·0	9 18·0
	Pt. Perallo	42 44·1	9 13·4

	(24) Places	Lat. N	Lon. E
	Calvi, Pt. Rivellata, lt. F 289f.	42° 35′·2	8° 43′·5
	C. Rosso, W pt.	42 14·3	8 32·5
	Sanguinares Is., ⅓ 1m., lt. F, Fl. 321f.	41 52·8	8 35·7
	Ajaccio, Cathedral	41 55·0	8 41·7
	C. Muro, SW pt.	41 44·5	8 39·5
	C. Campo Moro, ⚓, tower	41 38·5	8 48·5
Corsica ⊕	Pt. Seneteso, *h*, extr.	41 34·0	8 47·0
	C. Feno, lt. F 65f.	41 23·8	9 5·7
	Bonifacio, ⚓, lt. F 98f.	41 23·8	9 9·2
	Pertusato, lt. R 325f.	41 22·2	9 11·2
	Port. Sta. Manza, ⚓, Pt. Capicciolo, tower	41 25·1	9 15·7
	Porto Vecchio, ⚓, Chiape Pt., lt. F, Fl. 217f.	41 36	9 22
	E. extr. Fiorentina, tower	42 17·0	9 33·7
	Bastia, ⚓, Dragon bastion, lt. F 82f.	42 41·8	9 27·0
	Monte Stello, 4532f.	42 47·5	9 25·0
	Finocchiarola, tower	42 59·3	9 28·0
	ITALY. West Coast.		
	C. St. Martin	43 43	7 33
	Ventimiglia Pt.	43 45	7 43
	Mt. Grande, 3100f	43 50	7 37
	C. del Armi	43 49	7 54
	Port Maurizio, mole hd.	43 53·2	7 59·0
	C. de la Mele, *h*	43 58	8 11
	Gallinara I., tower	44 2·1	8 13
	Finale, Church	44 9·9	8 19·0
	Noli, Conv. St Francisco	44 11·9	8 22·7
	Vado, Fort St. Lorenzo	44 15·5	8 24·5
	Savona, ⚓[12], Citadel	44 18·4	8 27·7
	Polla rk.	44 25·0	8 40·0
	Genoa, ⚓. 3 lts., Int. 340f., F 92f, F 69f.	44 24	8 54·0
	Pt. Chiappa, sum.	44 20·0	9 10·5
	C. Porto Fino, fort	44 18·2	9 14·2
	Sestri di Levante, fort	44 16·4	9 25·5
	Port Venere, ⚓, N entr.	44 3·2	9 52·7
	Tino I., F. Fl. (electric) 384f.	44 1	9 51·0
G. of Genoa ⊕	Spezzia, ⚓, Castle	44 6·3	9 52·2
	Monte Altissimo, 5213f.	44 3	10 14
	Viareggio, Sanità	43 51·8	10 15·7
	Arno R., mouth, fort	43 40·8	10 16·7
	Pisa, leaning tow.	43 43·5	10 24·0
	Florence, Duomo	43 46·6	11 15·5
	Malora, shoal, lt. F 60f.	43 32·6	10 12·7
	Leghorn, ⚓, lt. Rev 154f.	43 32·7	10 17·7
	Gorgona I., NS 1½m., *h*, mid.	43 25·8	9 53·5
	Val di Vetro rf., ⅓ 3m., W pt.	43 18·2	10 21·7
	Castagnetto, fort	43 10·7	10 32·7
	C. Baua, tower	42 59·7	10 29·7
	Piombino, palace	42 55·7	10 31·7
	C. Troja, tower	42 48·1	10 44·5
	Castiglione, fort	42 46·0	10 53·0
	R. Ombrone, mouth	42 39	11 0·5
	Formiche, ⅓ 2m, N one 32f.	42 34·6	10 53
	Talamone	42 32·3	11 8
	St Stefano, centre of town	42 26·4	11 7·2
	Mt. Argentario, telegraph	42 23·2	11 10·5
	Capraia I., ⅓ 4m., fort.	43 3·2	9 50·5
	Palmajola I., NS ½m., lt. F, Fl 334f.	42 51·9	10 28·7
	Elba, N extr., or C. Vita	42 52·6	10 24·7

MARITIME POSITIONS

	(25) Places	Lat. N	Lon. E
Elba and Is. adjacent	Elba, Porto Ferrajo, ⚓, lt. F, Stella fort, 200f.	42° 48′·3	10° 20′·5
	— W. extr., or Pt. Mortigliano	42 46·2	10 6·2
	— Port Longone, Citad. Ch....	42 45·8	10 24·2
	— Mt. Calamità.....................	42 43·8	10 23·7
	Pianosa I., NS 3m., *l*, lt. Rev. 140f.	42 35	10 6
	Africa rk., or W. Formiche, 6f.	42 21·5	10 3·7
	Montecristo I., 6/16 3m., 2076f.	42 20·3	10 18·5
	Giglio I., 2/12 5m., S pt	42 19·2	10 55·1
	Giannuti I., 2/21 2m., S pt.	42 14·2	11 6·5
	Formica di Burano..............	42 23·0	11 13·5
Italy, W. Coast ⊕	Civita Vecchia, ⚓, lt. F, Fl. 121f.	42 5·7	11 47
	C. Linaro, rf. [¾m.]	42 2	11 50
	Tiber, R. Fiumicino, 2 lts. F.	41 46	12 13·5
	Rome, St. Peter's, dome.........	41 54·2	12 27·2
	—— Observatory	41 53·9	12 28·7
	Port Anzio, ⚓, lt. F, Fl. 92f.	41 26·9	12 37·5
	Monte Circello, lt. F 125f. ...	41 13·4	13 4·5
	Terracina, lt. F 26.....	41 17	13 15·7
	Gaeta, lt. F, Fl., St. Catherine tow., 237f.	41 12·4	13 34·7
	Mola, watering pl.	41 15·0	13 36·0
	Castel Volturno	41 2·5	13 57·0
	Parmarola I., NS 1¾m., N pt.	40 56·7	12 51·5
	Ponza I., 4/4 4m., (lt. F 200f.)	40 54·0	12 58·2
	Zannone I., EW 1m., lt. F, Fl. 38f.	40 58·2	13 3·7
	Botte, rks.	40 50·4	13 6·2
	Vandotena I., 4/4 1½m., T, Fort St. Nicola	40 47·5	13 26·0
	Ischia I., 5/16 5½m. Castle, E pt.	40 43·9	13 57·7
	Procida I., NS 2m., N pt., lt. F 76f.	40 46·2	14 1·0
	Baia, Castle	40 48·7	14 5·0
	C. Miseno, pt., lt. F, Fl. 292f.	40 46·5	14 5·2
	Pozzuoli, Church	40 49·2	14 7·2
	Naples, Obs. Capo di Monte...	40 51·8	14 14·7
	——, mole lt. F, Fl. 161f....	40 50·3	14 15·7
	Torre del Greco, W extr.......	40 47·2	14 21·7
	Mt. Vesuvius, 3900f.	40 49	14 26
	Castelamare, lt. F. Fl. 105f....	40 41·5	14 28·2
	Sorrento, Fort St. Anton.......	40 37·6	14 22·5
	Pt. Campanella, lt. Int. 85f. ...	40 34·0	14 19·5
	Capri I., EW 3m., S or Carena Pt., lt. F, Fl. 238f.	40 32·0	14 11·7
	Mt. St. Angelo, 4680f.	40 39	14 31
	Galli rks., tower..................	40 34·0	14 26·5
	Salerno, 2 lts. F 28f., 13f.......	40 39	14 45
	C. Licosa	40 14	14 53
	C. Palinuro, lt. F 675f..........	40 0	15 18
	Policastro	40 1	15 33
	Dino I., EW 3c., tower.........	39 48·0	15 48·7
	Cirella I., tower..................	39 37	15 50
	Mt. Cocuzza	39 16	16 16
	St. Eufemia.......................	39 3	16 15
	C. Vaticano, lt. F, Fl. 354f ...	38 37·2	15 50
	Gioja	38 24	15 56
	Scylla	38 14·5	15 45·0
	Reggio Church, lt. F 72f.......	38 7	15 39
Lipari Is.	Stromboli, 3030f.	38 48·2	15 13·7
	Panaria I., N pt..................	38 38·7	15 4·5
	Secca di Capo....................	38 37·2	14 54·5
	Salina I., Salvatore M., 3125f	38 33·2	14 50·7
	Lipari I., summit, 1978f.	38 29	14 50

	(26) Places	Lat. N	Lon. E
Lipari Is. ⊕	Vulcano I., 1601f., lt. F. Fl....	38° 22′·1	14° 59′·0
	Felicudi I., 2598f., Church ...	38 34·1	14 34·2
	Alicudi I., summit, 2172f.......	38 32·7	14 21·1
	Ustica I., 2/2 3m., Uomo-Morto pt., lt. F, Fl. 328f.	38 42·5	13 11·7
	SICILY.		
Sicily ⊕	Faro I., lt. F, Fl. 147f.	38 15·8	15 39·7
	Messina, ⚓, lt. F, Fl. 134f. ...	38 11·2	15 35·2
	Scaletta, fort	38 1·7	15 27·7
	Trizzi Tower	37 34·4	15 11·2
	Mt. Etna, 10,874f.	37 45	15 0·2
	Catania, Sciara Biscari, lt. F, Fl. 98f.	37 29	15 6
	C. Sta. Croce, lt. F 91f...	37 14·5	15 16
	Augusta Port, ⚓, lt. F, Fl. 88f.	37 12·8	15 14
	C. Panagia, pt.	37 6·5	15 17·0
	Syracuse, ⚓, w. r, lt. F 82f....	37 3·0	15 18·5
	C. Morro di Porco, lt. Fl. 108f.	37 0·0	15 21
	Avola	36 55·2	15 8·0
	Passaro I., NS 1m., lt. F, Fl. 137f	36 41·2	15 9·7
	— S extr., or Correnti I......	36 38·5	15 5·2
	C. Scalambri, lt F 124f.	36 47	14 29·7
	Terra Nuova, Col................	37 2·9	14 15·0
	Licata, Castle, lt. F 32f.........	37 6·0	13 57·0
	Rossello, lt. F, Fl. 324f.	37 17·5	13 27·7
	Girgenti, ⚓, Mole lt., 3 lts. F	37 17	13 32·5
	C. Bianco, 90f., (shl. ½m. S), tower	37 23·2	13 17
	C. St. Marco, fort, tow.........	37 29·5	13 2
	C. Granitola, lt. F 123f.	37 33·7	12 40·2
	Mazzara, Cathedral	37 29·2	12 35·7
	Marsala, lt. F, Fl. 65f.	37 47·4	12 27
	Trapani, ⚓, Columbara, lt. F, Fl. 134f.	38 0·7	12 30·2
	St. Julian, Castle	38 22·7	12 36
	Maritimo I., NS 3m., 2376f., N pt., Castle	37 58·7	12 3·7
	Levanso I., 2/2 3m., N pt., T, tow.	38 1·6	12 21·0
	Favignana I., EW 5m., St. Cath. Castle, 1249f.	37 55·7	12 19·2
	Porcelli rks., 4/4 ¾m., T	38 4·5	12 27·0
	Formiche, lt. F 85f.	37 59	12 26
	C. St. Vito, lt. F, Fl. 142f. ...	38 11·1	12 44·2
	Castel a Mare, Petrolo Pt.......	38 2·5	12 54
	C. di Gallo (1692f.), lt. F 148f.	38 13·5	13 10·2
	Palermo, ⚓, Observatory ...	38 6·7	13 21·5
	C. Zaffarana, lt. F 111f.	38 6·5	13 32·5
	Termini, fort, lt. F 30f.	37 59·5	13 42·2
	Cefalu, Cathedral	38 2·2	14 1·7
	Caronia, Castle	37 59	14 27
	C. Orlando, ⊥, Castle	38 9·8	14 45·0
	C. Calava	38 12·5	14 54
	Milazzo, lt. F 288f.	38 16·1	15 14·0
Pantellaria, &c.	Skerki Bank, ı	37 45·5	10 49·7
	Keiths rf., ı.......................	37 48·6	10 56·6
	Pantellaria I., S. Leonardo, windmill.........	36 50	11 57
	——— sum. 2730f.	36 46·8	12 0·5
	Grahams shl., 18f.	37 9	12 43
	Linosa I., 4/4 1¾m., landg. cove	35 51·8	12 52·0
	Lampion I., 2/2 ¼m.	35 32·8	12 20·0
	Lampedusa I., EW 6m., T, ⚓, Castle	35 29·2	12 35·2

MARITIME POSITIONS

(27) Places	Lat. N	Lon. E
MALTA.		
Malta ⊕		
Valetta, ⚓, Palace	35° 53.8	14° 31.2
SPENCER'S MONUMENT	35 53.0	14 30.7
St. Elmo, lt. F 167f.	35 54.1	14 31.5
SE extr., Pt. Dellamara, (rf 1½m.), lt. R 151f.	35 49.2	14 34
Gozo I., 6/5 9m., NW pt., or C. Demitri, lt. Rev. 400f.	36 4.2	14 13.2
ITALY.		
Italy, South Coast		
C. delle Armi, tow., lt. F 312f	37 57.1	15 41.2
C. Spartivento, F. Fl. 210f.	37 55.5	16 3
Bruzzano C.	38 2	16 8.2
Marina de Monasteraci	38 26	16 34.5
C. Rizzuto, pt.	38 53.5	17 5.5
C. Colonne, lt. F 133f.	39 1.5	17 12.2
Cotrone, lt. F 30f.	39 5.6	17 8.5
Pt Alice, tower	39 24	17 8
Pt. del Trionto, tower	39 37	16 46
Roseto	39 59	16 35.7
Tarento, ⚓, Citadel	40 28.2	17 14
C. St. Vito, lt. F, Fl. 150f.	40 24.5	17 12.5
Port Cesareo, tower	40 15.6	17 53.7
Gallipoli, St. Andrea I., 2/2 ¾m., mid. (N pt., lt. F. Fl. 149f.)	40 2.7	17 57.2
ADRIATIC.		
Adriatic, W. Coast ⊕		
C St Maria di Leuca, lt F, Fl. 345f.	39 47.7	18 22.5
Gagliano	39 51	18 20
C Otranto, Telegr. (E pt. of Italy)	40 8.6	18 29.7
Port Otranto, ⚓, lt. F 197f.	40 6	18 31
Brindisi, ⚓7, Telegr, lt. F 106f.	40 39.3	17 5?.2
Torre della Testa	40 41.4	17 52.5
Monopoli, Telegr., lt. F 50f.	40 57.1	17 18.2
Bari, St. Cataldo, lt. F, Fl. 49f.	41 8.3	16 51
Molfetta, tow., lt. F. Fl. 65f.	41 13	16 36.0
Barletta, ⚓8, (lt F), 69f.	41 20	16 18.7
Manfredonia, lt. F, Fl 65f.	41 37.7	15 55.5
Mt. Nero, 3336f.	41 43	15 41
Vies c. Sta Croce, lt. F	41 53.3	16 11.2
Termoli, tower	42 0.2	15 0
Tremiti Is., 4 3m., Semaphore	42 7.3	15 30.5
Pianosa I., l, EW de., E pt.	42 13.5	15 45.2
Pelagosa Is., 2, 5 1m., lt. F. Fl.	42 24	16 16
Pt. Penna, tower	42 10.4	14 43.0
Ortona, Ch., lt. F 39f.	42 19.7	14 24.5
Mt. Brancastello, 7697f.	42 27	13 39
Montepagano, 1046f.	42 40.5	13 59.5
Giulianova	42 45	13 59
Colonella, sum. 1096f.	42 52	13 54
Grottamare, Church	42 59.8	13 52.2
Pedaso, Church	43 6.4	13 53.0
Fermo, Cath., 1197f.	43 9.5	13 43.5
Loretto, Ch., 565f	43 26.3	13 37
Mount Conero, Telegr.	43 33.3	13 36.5
Ancona, lt. N mole, 34f.	43 37.7	13 30.5
Sinigaglia, lt. F 15f.	43 43.7	13 13.5
Fano, lt. F 58f.	43 51.3	13 0.7

(28) Places	Lat. N	Lon. E
Pesaro, lt. F 30f.	43° 55.3	12° 54.7
Rimini, lt. F 67f.	44 4.3	12 35
Ravenna, tower	44 25	12 12.5
Goro, ⚓, W mo. of the Po.	44 48	12 23
Chioggia, ⚓, Cathedral	45 12.9	12 17.0
Port Malamocco, ⚓, N mole	45 20	12 20.7
S. Nicolo, Port Lido, ⚓, fort, lt. 9f.	45 26	12 23.5
Venice, St. Mark	45 26	12 20.5
Venice, Instituto di Mar Mer	45 26.2	**12** 20.5
Piave Vecchia, lt. F 146f.	45 28.6	12 33.2
R. Tagliamento, fort mouth	45 38.2	13 6.2
Port Buso, lt. Rev. 11f.	45 43	13 15
Grado, Ch. (lt. F)	45 40.6	13 23.2
Monfalcone, Church	45 48.3	13 32.2
Trieste, ⚓, lt. Fl Sta Teresa mole hd. 110f	45 38.8	13 46.2
Capo d'Istria, Church	45 32.7	13 44.2
Pirano, St. G. Church	45 31.6	13 34.2
Salvore Pt., Pt. Bassania, lt. F 112f	45 29.5	13 29.5
Citta nuova, ⚓, Church	45 18.8	13 33.7
Parenzo, Church	45 13.6	13 35.7
Rovigno, ⚓, Pelago I., lt. 42f.	45 2.2	13 36.7
POLA, ⚓, OBSERVATORY	44 51.8	13 50.7
C. Promontore, Porer rk, lt. F 111f., (rk. SSE 1½m.)	44 45.2	13 53.5
Adriatic, E. Coast ⊕		
Albona, Church	45 5.1	14 7.7
Fianona, Church	45 8.2	14 11.0
Fiume, clock tower	45 19.6	14 26.7
Porto Re, Di Ostro Pt., lt. F, Fl. 54f.	45 16.7	14 34.2
Segna, mole, lt. F 27f.	44 59.6	14 54.0
Carlopago, mole	44 31.7	15 4.7
Nona, Cathedral	44 14.6	15 11.2
Zara, lt. F 17	44 6.8	15 12.0
Zara Vecchia	43 56.3	15 26.7
Galiola rk.	44 43.5	14 11.0
Unie Bay, Islet, [2c.]	44 38	14 14
Sansego I., 5 2m, 350f. sum	44 30.9	14 18.2
Grivizza I., [½m.]	44 24	14 33
Sette Bocche Chan., N or Bonastra Pt.	44 12.3	14 49.0
Mt. Vela Strazza, 1070f	43 59	15 2
Zuri I., 6/5 7m., E pt., Massarina I.	43 37.5	15 44
Sebenico, Castel Vecchia, lt. F 18f.	43 44.2	15 53.7
Zirona piccola, I., sum.	43 27	16 4
Trau, St. John's Church	43 30.9	16 15.2
Spalato, Boticella pt., lt. F, Fl. 35f.	43 30.4	16 26.7
Makarska, lt. F	43 17.5	17 1.0
Solta I., 6/5 10m., SE pt.	43 19	16 23
Brazza I., EW 7 l. St. Vito, sig. st. mid.	43 16.7	16 37.5
Lessina I., EW 12 l., Pokonjidol I., lt. F 76f.	43 9	16 27
Lissa I, EW 9m., Port St. Georgio, St. Francis Ch., 2 lts. F 72f., 14[illegible]	43 3.4	16 10.2
Busi I., 2¼m., sig. st.	42 58	16 2
St. Andrea in Pelago, 1¼m., 1000f., ‡	43 1.7	15 45.7
Pomo rk., [2c.], ⊥	43 5.5	15 27.7
Pomo rk., [2c.], ⊥	43 5.5	15 27.7
Proisdo I., EW 1m., (off W pt. of do)	42 59	16 37

MARITIME POSITIONS

Region	(29) Places	Lat. N	Lon. E
Adriatic, E. Coast ⊕	Curzola I., EW 8 l., Fort St. Biaggio	42°57′·4	17° 8′·0
	Glavat I., lt. F, Fl. 121f.	42 46	17 9
	Cazza I., 4/4 2m., sig. st.	42 46·0	16 31·0
	Cazziola I., 6/6 1m.	42 45	16 43
	Lagosta I., EW 7m., St. George Chap., lt. F 342f.	42 43·0	16 53·0
	Lagostini rks., EW 3½m., E sum.	42 45·8	17 9·0
	Meleda I., 6/5 7 l., W pt.	42 47	17 18
	— Port Palazzo, ⚓. ruin	42 46·8	17 21·7
	Ragusa, ⚓, fort, W bast.	42 38·9	18 7·0
	Markana Is., grp., 4/4 2m., sum	42 34·3	18 12·0
	Molonta I., sum.	42 29·9	18 23·5
	Pt Ostro, lt. F, Fl. 263f.	42 23·4	18 31·7
	Kattaro, Sanità	42 25·4	18 46·5
	Vetergnach, 3960f.	42 19	18 52
	Budua, Greek Church	42 16·5	18 50·5
	Antivari, Volovica Pt., lt. F	42 5·3	19 4·5
	Menders Pt., lt. F 33f.	41 57	19 9·5
	Dulcigno, ⚓. la Cala beach	41 55	19 12·5
	C. Rodoni, 400f., lt. Fl.	41 35	19 27·2
	C. Pali, sum.	41 24·7	19 24·2
	Durazzo, mole, lt. F 52f.	41 18·2	19 27·2
	C. Laghi, tower	41 10·2	19 25·5
	Avlona, or Valona, ⚓, w, Custom house	40 27·2	19 26·7
	Sasseno I., 2/2 2m., sum. 1000f.	40 29·2	19 14·2
	C. Linguetta, ⊥, 2290f.	40 26·7	19 17·7
	Mt. Cica, 6300f.	40 15	19 35
Albania	Port Palermo, ⚓, fort	40 2·9	19 48·2
	C. Kiephali	39 54·3	19 55·5
	Tignoso, lt. F 100f.	39 47·2	19 58·5
	Port Gomenitza, ⚓, Dogana	39 29·7	20 17·1
	Parga, w, Madonna I.	39 16·4	20 25
	Mt. Zarothema, 3000f.	39 11·2	20 38
	Prevesa, Fort Giorgio	38 56·7	20 46·2
	Vonizza	38 55	20 53·7
	IONIAN ISLES.		
Ionian Is. ⊕	Fano I., 6/6 3½m., 1339f., lt. F, Fl. 340f	39 51	19 27
	Merlera, NS 2m., sum.	39 53·2	19 36
	Samothraki I., 4/4 2½m., N pt.	39 46·7	19 31·5
	Corfu, Citadel, lt. F 240f. ... ⊕	39 37·0	19 56·7
	— C. Drasti	39 47·6	19 41·5
	— Mt. St. Giorgio, 1288f.	39 36	19 48·0
	— C. Bianco, pt.	39 21·2	20 7·7
	— Vido I., Fort Alexander	39 38·2	19 56·5
	Paxo I., 4/4 4½m., NW pt., Laka, lt. F 416f.	39 14·4	20 8·5
	— Port Gajo, ⚓	39 12	20 13
	Antipaxo I., 6/6 2m, E pt	39 8·7	20 14·0
	Sta. Maura, lt. F mole, 54f.	38 50·5	20 43
	— Sesola rk., 114f.	38 41·5	20 33·5
	— Mt. Stavrota, 3700f.	38 41·0	20 38·5
	— S extr., C. Ducato, ⊥, 200f.	38 33·5	20 33·7
	Ithaca, N pt.	38 30·0	20 40·0
	— Vathy, Port, ⚓. Lazaretto	38 22·1	20 43·5
	— SE pt., or Iganni Pt.	38 19	20 40·7
	Cephalonia, N extr.	38 28·5	20 34·0
	— C. Aterra, pt.	38 21·5	20 25
	— Guardiana I., lt. F 112f.	38 8·4	20 26·5
	— Port Argostoli, C.S. Theodoros	38 11·6	20 29

Region	(30) Places	Lat. N	Lon. E
Ionian Is.	Cephalonia, St. George, Castle, 1050f.	38° 8′·5	20°34′·0
	— Sum., or Mt. Elato, 5218f.	38 8·5	20 41·0
	— S pt., or C. Monda	38 3·6	20 48
	Zante, N pt., or C. Skinari	37 56·2	20 42·2
	— Mt. Vachronis, 2724f.	37 48·8	20 42·7
	— S pt., C. Marathia	37 39	20 50
	— Ieraki Pt.	37 42·5	20 59·2
	— Mt. Scopo, 1621f.	37 45	20 56·2
	Krio Nero, lt. F 93f.	37 48·2	20 54·5
	GREECE.		
Greece, W. Coast ⊕	Dragomesti Bay, Astoko	38 32	21 5
	Oxia I., pk., 1411f.	38 18·7	21 7
	Messalonghi	38 21·9	21 25·7
	Pt. Bakari	38 17	21 31
	Roumelia, Castle	38 19·5	21 46·2
	Lepanto, Castle	38 23·8	21 49·0
	Corinth, Acropolis	37 53·5	22 52
	Morea Castle, centre	38 18·5	21 47·0
	Patras, w′, lt. F, Fl. 65f.	38 15·1	21 43·5
	C. Papas, ruined fort	38 12·7	21 23·5
	Montague rks., 2, 4/4 1m., 16f.	37 55	21 0
	Konoupoli Pt.	38 6	21 23
	C. Glarenza, ruin	37 56·8	21 8·5
	Kastro Tornese, 795f.	37 53·7	21 8·7
	C. Katakelo, *h*	37 38	21 19·0
	Stamphanes Is., 4/4 2½m., T, *l*, lt. F 127f.	37 15·3	21 0·2
	C. Kunello	37 10	21 34
	Proti I., NS 2m., sum. 605f.	37 3·4	21 33·5
	Sphaghia I., 2/2 2½m., S pt.	36 54·5	21 40·5
	Navarino, Pylos I., lt. F 116f.	36 54	21 41
	Mt. St. Nicolo, 1542f.	36 53·0	21 42·0
	Modon	36 48·4	21 42·5
	Sapienza I., NS 5m., sum. 740f.	36 46·6	21 42·2
	Cabrera I., 2/2 5m., S extr.	36 41·7	21 47
	C. Gallo	36 42·9	21 52·7
	Venetico I., NS 1½m, (Ants. SSE 2m). sum 570f.	36 41·7	21 53·7
	Koron, w′ N 2m., r, Livadia Pt.	36 47·5	21 58·5
	Kalamata, highest ruin	37 2·6	22 7·2
	C. Kitries	36 54·7	22 8·0
	Mt. Makrino, 7900f.	36 56·5	22 22·2
	Limeni, ⚓	36 40·6	22 13
	C. Grosso, ⊥, *h*, sum.	36 28·6	22 22·2
	C. Matapan, ⊥, *h*, lt. F, Fl. 133f.	36 22·5	22 29·2
	C. Stavri	36 36·2	22 32·5
	Marathonisi	36 44·6	22 35·0
	Eurotas R., mouth	36 48·2	22 41
	C. Xyli, (pk. 1040f. N 1′·5), pt	36 39·0	22 49·5
	Servi I., NS 3½m., S and E pt.	36 27·0	22 59·5
	C. St. Angelo, *h*, ⊥, pt.	36 26·0	23 12·0
Cerigo I.	Cerigo I., N. pt., C. Spathi, lt. F, Fl. 362f.	36 23·0	22 57·2
	— Fort St. Nikolo	36 13·1	23 5·0
	— S extr.	36 7·7	22 59·7
	Ovo I., NS 8c., 550f., T	36 5·5	23 0·0
	Nautilus rk, [½m]	35 56	23 13
	Pori I., 6/2 ¼m, 410f.	35 58·5	23 15
	Cerigotto I., 2/2 6m., sum. 1230f.	35 50·1	23 18·0

MARITIME POSITIONS

	(31) Places	Lat. N	Lon. E
Greece, East Coast	Mt. Krithina, 2600f.	36° 28·2	23° 8·2
	Karavi I., rk., T	36 46·1	23 36·5
	Falconera I., 4/5 1¼m., h, sum.	36 50·9	23 53·7
	Belo Poulo I., 4/5 1¾m., T, sum.	36 54·9	23 27·7
	Spezzia I., 4/5 4½m., sum. 812f.	37 15·3	23 8·7
	Trikeri I., NS 1m., N sum.	37 16·2	23 17·0
	Napoli di Romania	37 33·6	22 48·0
	Hydra, 6/6 11m., sum. 1939f.	37 19·5	23 28·0
	Stavronisi I., EW ½m.	37 15	23 27
	St. George d' Arbora I., 4/4 3m., sum. SE part, 1085f.	37 28·0	23 56·0
	Poros I., EW 5m., ⚓', W pt., lt. F 96f.	37 32	23 26
	Methana, Mt. Khelona, 9429f.	37 36	23 22
	Egina I., 4/4 8m., Mt. St. Elias, on S part, 1752f.	37 41·9	23 30·0
	Kalamaki, E. ent. canal	37 55	23 0
	Ledsina I., or Eleusis, tow.	38 2·4	23 32·2
	C. Themistocles, lt. F. 51f.	37 5	23 28
	Piræus, 2 lts. F	37 56·2	23 38·0
	Athens, Parthenon	37 58·1	23 43·7
	—— Observatory	37 58·3	23 44
	C. Colonna temple, 269f.	37 38·8	24 1·7
	Port Mandri, ⚓, w., pk.	37 44·3	24 3·7
	Macronisi I., 2/2 7m., S pt.	37 38·5	24 6·7
	Port Raphti, ⚓', St. Nicolao	37 53·0	24 1·0
	C. Marathon	38 7·1	24 3·7
	Petalies, or Split Is., sum.	37 59·5	24 16·2
	ARCHIPELAGO.		
Archipelago	Zea I., 2/2 10m., Mt. St. Elias	37 37·3	24 21·7
	— Port St. Nicolao, ⚓, lt. F Fl. 108f.	37 40	24 19
	Thermia I., 2/2 10m., sum. 966f.	37 22·5	24 26·2
	Piperi I., EW ½m., sum.	37 18·2	24 32·0
	Serpho Poulo Is., EW 1½m., mid.	37 15	24 36
	Serpho I., 4/4 7½m., sum. 1585f.	37 10	24 30
	Sipharto I., 2/2 9m., N pt.	37 2·7	24 38·5
	Anti Milo, NS 2m. sum.	36 48	24 15
	Ananes rks., 6/6 ½m.	36 33	24 9
	Milo, EW 11m., Mt. St. Elias, on SW part, 2480f.	36 40·5	24 23·2
	— Port, ⚓, W pt., Pt. Vani	36 45·3	24 22·7
	Argentiera I., NS 5m.	36 49·3	24 33·5
	Polino I., 4/4 3½m., sum.	36 46	24 39
	Peignes rks	36 38	24 35
	Policandro I., 4/5 2 l. sum.	36 37·1	24 55·2
	Sikyno I., 4/4 7m., sum.	36 40	25 6
	Nio I., 4/5 8m., sum	36 42·7	25 21·0
	Amorgo Poulo I., NS 2m.	36 36·9	25 42·7
	Santorin I., NS 8m., Mt. St. Elias, on SE part	36 22·0	25 28·7
	Christiana I., (*Askana*), 4/4 1m.	36 15	25 13
	Anaphi I., 2/2 7m., sum.	36 23	25 47
	Hermonisi I.	36 32	26 10
	Stampalia I. or Astropalaia, 4/4 4 l., SW sum.	36 32·2	26 19·7
	Levita I., EW 4m., E pt.	37 0·0	26 32·0
	Zinari I., 2/2 2m., W pt.	36 58·7	26 17·7
	Amorgo I., 2/2 18m., sum. near mid., 2175f.	36 50·7	25 55·7
	Karo I., EW 4m., mid.	36 53	25 40
	Skinosa I., 4/4 2½m., SE pt.	36 51·0	25 33·0
	Heraclia I., 4/4 4m., sum.	36 49·7	25 27·5

	(32) Places	Lat. N	Lon. E
Archipelago	Naxos I., 12/2 18m., Mt. Zia, SE-d of mid., 3290f.	37° 1·8	25° 31·2
	— N pt., or C. Stauro	37 12·5	25 33·0
	Paros I., 4/4 12m., 2530f., C. Koraka, lt. F, Fl. 193f.	37 9	25 14
	Boidi, or Buey rk., T	37 14·5	25 56·7
	Antiparos, NS 7m. S pt.	36 56·0	25 5·0
	Strongylo I., 2/2 1¼m., S pt.	36 56·2	24 57·5
	Stapodia, 6/6 1½m.	37 25	25 35
	Myconi I., 6/6 8m., E sum. 1150f.	37 27·5	25 27·2
	Rhenea, NS 4½m., S pt.	37 22·0	25 14·0
	La Nata, rk., (rk. W ¼m.)	37 21·7	25 4·0
	Syra I., NS 9m., 1415f.	37 28·9	24 55·7
	— Gaidaro, lt. R 224f.	37 25·5	24 59·0
	Jura I., 6/6 5m., W pt.	37 36·2	24 39·5
	Tinos I., 6/5 15m., 2340f.	37 35·0	25 14·5
	Andros I., 4/4 22m., Mt. Kovari, W side, mid., 3200f.	37 50·1	24 50·5
	— C. Fassa, lt. F, Fl. 708f.	37 57·6	24 41·7
	Kaloyeri rks., NS 2m.	38 10	25 17
	Negropont, Euripo. lt. F 39f.	38 28·7	23 36·5
	— C. Doro, islet off, 93f	38 9·4	24 36·5
	— C. Kumi	38 39	24 9·7
	— Mt. Delphi, 5730f.	38 37·4	23 50·7
	G. of Volo, C. Kavoulia, lt. F 85f.	39 6	23 4
	Volo, fort	39 24·0	22 56·5
	Skyro I., 4/2 5 l., rf. N end, Mt. Koklulas, 2565f.	38 49·7	24 36·5
	Skyro Poulo, [1m.], 617f.	38 50	24 22
	Skantzura I., NS 1 l., mont.	39 5	24 6
	Adelphi Is., 2/2 1½m., 521f.	39 5·8	23 59
	Kheliodromi, 4/4 4 l., N sum. 1590f.	39 10	23 53
	Skopelos I., 4/4 11m., sum. 2149f.	39 8·8	23 40·2
	Skiathos I., 6/6 6m., ✝, Mt. Stavros, 1448f.	39 11·4	23 28·2
	Pelago, NS 2 l., sum. 1050f.	39 20·4	24 3
	Psathoura I., lt. Fl. 129f.	39 30	24 10·7
	Mt. Pelion, 5310f.	39 26·5	23 3
	Ossa, Mt., 6407f.	39 48·0	22 42·0
	TURKEY.		
Turkey, South Coast	Mt. Olympus, 9754f.	40 4·7	22 22·0
	Salonika, ⚓	40 37·8	22 57·2
	C. Kassandra, *l*, lt. Fl. 72f.	39 57·2	23 22·0
	C. Pailluri, *l*	39 55	23 44·7
	C. Drapano, 880f.	39 56·5	23 56·2
	Mt. Athos, sum. 6349f.	40 9·5	24 20·0
	Pilaf Tepe, 6143f.	40 53·5	24 5·2
	Kavala B., lt. F 148f.	40 55	24 25
	Thaso I., NS 14m., sum. 3428f.	40 41·7	24 42·7
	C. Fenar, lt. F 72f.	40 56·7	25 8·5
	Marona, hill, 2174f.	40 52·7	25 32·5
	C. Makri, w', 6/6 1m.	40 49·5	25 45·0
	Dédéagatch, lt. Rev. 115f.	40 50	25 55
	Enos	40 42·0	26 5·0
	Xeros I., NS ½m.	40 30·5	26 44·0
Lemnos Is.	Samothraki, 4/5 12m., 5248f.	40 27·0	25 35·5
	W pt., C. Aktotiri, *l*	40 28·2	25 27·0
	Zurafa rk.	40 27·5	25 50·5
	Strati I., 2/2 5½m., 973f.	39 31·0	25 1·7
	Lemnos, 2/2 7 l., W pt., or C. Mourtzephlos, 1410f.	39 58·7	25 2·0
	— Moudros, ⚓	39 52·0	25 16·2

MARITIME POSITIONS

(33)	Places	Lat. N	Lon. E
Sea of Marmara	Lemnos, S pt., or C. Irene ...	39° 46′·6	25° 21′·5
	— N and E pt., C. Plaka	40 1·7	25 27·0
	Imbros, $\frac{6}{6}$ 5l. sum. 1959f. ...	40 10·6	25 49·0
	— W pt., or Pt. Auflaka	40 7·2	25 40·0
	Dardanelles, Asia Castle, lt. F 50f.	40 9·0	26 24·5
	Gallipoli, lt. Rev. 120f.	40 24·0	26 41
	Koutalai I., Roun rk, lt. F 49f.	40 31·0	27 28·5
	Marmara I., Fanar Adasi, lt. F. Fl. 134f.	40 38	27 45
	Pasha harb., ⚓, Liman	40 29·5	27 36·2
	Rodosto	40 59·7	27 31·0
	Erekli, lt. F 184f.	40 58·5	27 58·0
	CONSTANTINOPLE, ST. SOPHIA	41 0·3	28 59·0
	Bosporus Seraglio pt., lt. F, Fl. 117f.	41 0	29 1
	Roumili, lt F 190f.	41 14	29 7·2
	Fanar Bournou, lt F 83f. ...	40 57·7	29 2·2
	Proti I., [1m.] Vill. E side ..	40 54·0	29 3·5
	Dil Burnu, lt. F 40f.	40 44·5	29 30·7
	Ismid	40 45·7	29 55
	C. Bos Burnu, 1050f.	40 32	28 47
	Gemlik or Kios	40 26	29 9·5
	Kalolimno I., NS 4m. N sum.	40 34	28 32
	BLACK SEA.		
Black Sea	Kilios, tow	41 10·8	29 37
	C. Karábournú, N pt. lt. Fl. 362f.	41 21·7	28 41·2
	C. Kouri	41 52·7	28 3·0
	Cizópol	42 26·3	27 43·7
	Bourgas, Minaret	42 30·3	27 30·7
	Akhiólo, Mosque	42 34·0	27 40·5
	C. Emeneh, E pt., lt. Fl. 207f	42 42	27 55·7
	Varna, Mosque, mid	43 12·0	27 56·5
	C. Kaliagri, ruin	43 22·1	28 29·7
	C. Shabler lt., F 120f.	43 32·7	28 37·7
	Kustenjeh, C., lt. F 68f.	44 10·5	28 41·0
	Portitski Mouth	44 40·5	29 1·7
	Danube R., Sulina mo. lt. F 70f.	45 9·3	29 40·5
	Serpent's I., w, lt. R 194f. ...	45 15·5	30 14·2
	Tsaregradskoe mo. 2 lts. F 52f.	46 4·8	30 29·7
	Akerman, Church	46 11·9	30 20·2
	C. Fontane, lt. F 200f.	46 22·8	30 45·5
	Odessa, ⚓, Reidovi mole, lt. F, Fl. 63f.	46 30	30 46
	— OBSERVATORY	46 28·5	30 45·5
	Berezan I., $\frac{2}{2}$ $\frac{1}{2}$m., fort	46 35·6	31 23
	Kinbourn lt. v. 2 vert.	46 35·4	31 29·2
	Otchakov., Church	46 36·4	31 32·2
	Nicolayev, ⚓, Observatory ...	46 58·2	31 58·0
	Kherson, Cathedral	46 37·7	32 38·0
	Tendra I., *l*, $\frac{2}{2}$ 8m. N end, beac.	46 21·7	31 32·0
	— lt. Rev. 96f. bell	46 18·9	31 30·2
	Armiansk, Church	46 7	33 43
	C. Jarkan, lt. F 117f	45 20·7	32 29·7
	Eupatoria pt. lt. F, Fl. 52f. ...	45 9·7	33 15
	C. Khersonese, *l*, lt. Rev. 116f.	44 35	33 22·2
	Sevastopol, ⚓, Church	44 37·9	33 29·5
	C. Sariteh, pt	44 23	33 44
	C. Aitódor, lt. F 315f.	42 25·3	34 7·7

(34)	Places	Lat. N	Lon. E
Sea of Azov	Mt. Tchatirdag, SW sum	44° 44′·0	34° 17′·2
	C. Meganom	44 46·7	35 7
	O. Karatlamà, sum	44 57·0	35 22
	C. Theodosia	45 0	35 26
	C. Chaouda, S pt., lt. F Fl. 120f.	44 59·5	35 50
	C. Takli, lt.	45 5·9	36 27
	Kertch, ⚓, Church	45 21·2	36 29·5
	Yenikaleh, lt. Fl 409f.	45 23·1	36 39·2
	C. Kazantip, sum.	45 28·0	35 54·0
	Arabat, E bast.	45 17·9	35 29·5
	Ghenitchesk, lt. F 81f.	46 11·0	34 52
	Berdiansk, lt. F 165f.	46 46	36 48·2
	C. Bielosarai, lt. F 73f.	46 52·5	37 20·7
	Mariupol, Church	47 5·3	37 35·5
	Taganrog, lt. F 161f.	47 12·2	38 57
	Azov, Cathedral	47 7·0	39 26·5
	Long nos	46 48	38 35
	Gheisk, lt. F 34f.	46 43	38 17
Black Sea	Taman	45 13·0	36 44
	Anápa, lt. F 98f	44 54·1	37 18·5
	Ghelenjik, ⚓, fort	44 33·4	38 3·2
	High Summit, 4m. inland	43 17	40 16
	Soukoum, fort, lt. Rev. 121f...	42 59·3	40 59·7
	C. Batoum, Mosque, lt. F 65f.	41 39·4	41 37·0
	Rezo	41 3·0	40 31·5
	Trebizonde, ⚓, lt. Fl. 105f. ...	41 1·0	39 46·0
	C. Ieros, T, N pt., lt. Fl. 98f...	41 7·7	39 26·0
	Triboli	41 1·0	38 49
	Keresoun	40 57·2	38 24
	C. Yazon, *l*, rks	41 8·5	37 41·5
	Eunieh, S. Mosque	41 7·7	37 17·7
	Samsoun, N lt. F 56f.	41 19	36 21·2
	C. Kizil Ermak, W. mo. riv....	41 44	35 58
	Sinope, Castle, lt. F 344f.	42 1·2	35 12·5
	C. Indjeh, lt. F, Fl. 92f.	42 6	34 58
	C. Kerempeh, lt. Fl. 262f.	42 1	33 17·2
	Amastra, E extr, lt. Fl. 312f...	41 45·3	32 24·5
	C. Babà, lt. F 657f.	41 18	31 26
	Kephken Adassi I., lt. F 98f...	41 14	30 17·5
	ASIA MINOR.		
Asia Minor	Rabbit Is., *l*, $\frac{4}{4}$ 2m., W extr.	39 55·5	26 3·7
	Tenedos I., $\frac{6}{6}$ 6m., rf. NW-d., sum.	39 50·2	26 5
	C. Baba, fort	39 28·2	26 4·5
	Mt. Ida, 5750f.	39 42·0	26 50·5
	Adramyti	39 35·5	27 2·5
	Mityleni, $\frac{6}{6}$ 13 l., E pt., C. Agia Maria	39 0·7	26 37·7
	— Mt. Olympus, 3079f.	39 4·2	26 22·0
	— Caloni, ⚓, Isl.	39 4·7	26 5·5
	— W. pt. C. Sigri, lt. Rev. 180f	39 13	25 51
	SMYRNA, MILL ON DARAGAZ PT.	38 26·5	27 9·7
	Vourla Scala, fountain	38 21·7	26 47·5
	C. Karabournou, pt.	38 39·9	26 22·7
	Scio, NS 27m., N sum. 4157f.	38 33·7	26 1·2
	Venetico I., off S pt. of Scio, T	38 8·0	26 2·0
	Psara I., $\frac{2}{2}$ 5m., S pt	38 32	25 35
	Antipsara, W pt.	38 32	25 31
	C. Blanco	38 16·6	26 14·7
	C. Koraka, T	38 6·5	26 36·7
	Sighajik, ⚓	38 12·0	26 48·2

MARITIME POSITIONS

(35)	Places	Lat. N	Lon. E
Asia Minor	Scala Nuova, lt. F 98f.	37° 51′5	27° 16′5
	Samsum Dagh, 4130f.	37 39·8	27 9 0
	C. Monodendri, ruin	37 21·3	27 13 0
	Wreck rk. 21f.	37 9 0	27 17·7
	Budrum, ⊞, Castle	37 2 0	27 27 5
	Port Giova	37 3 5	28 22
	C. Krio, W pt.	36 41·0	27 23·5
	Iujah Pt.	36 39 4	27 42 7
	Symi I. grp. NS 9m. S islet, Trompetto	36 30·7	27 54·2
	C. Aloupo	36 33·0	28 1·0
	ARCHIPELAGO.		
	Samos, Mt. Kerki, 4725f.	37 43 8	26 38·5
	— Vathi ⊞, port. lt. F 260f.	37 47	26 58
	— S pt., or C. Colonna	37 38·3	26 52·7
	Furni Is., NS 11m., S extr. rk.	37 28 4	26 31 2
	Nikaria, 22m. W pt., or C. Papas, lt. F, Fl.	37 31·2	25 59·5
	Mt. Melissa, 3300f.	37 32·2	26 4·7
	Gaidaro, EW 4m. sum. 720f.	37 28 1	26 58 7
	Arki, 4m. N pt.	37 24 9	26 44 5
	Patmos, NS 7m. Prasso Islet	37 16 0	26 34·7
	— Scala, ⊞, pier	37 19 5	26 34 0
	Lipso, 4½m. SW pt.	37 18 2	26 44·2
	Lero, 8m., Mt. Klidi, 1000f.	37 10 7	26 51·5
	Kalmno, 10m. Mt. Parasiva, 2250f.	36 58·8	27 0·0
	Saphonidi, ½m. sum.	36 53·0	26 56·7
Archipelago ⊕	Kos, 24m. W pt.	36 43 1	26 56·5
	Madona I. sum., lt. F, Fl.	36 30·5	26 57·5
	Nisero, EW 4½m. sum. 2270f.	36 35 5	27 11·0
	— W Islet off, 1m., N pt.	36 35 6	27 3·5
	Piskopi, 8½m., sum. 2097f.	36 26 1	27 21 0
	Karki, EW 5m., SW pt.	36 12 2	27 33·2
	Rhodes, ⊞, lt. Rev. 82f.	36 26·9	28 16·2
	— W pt, C. Mon litho	36 8 7	27 43 2
	— S pt. C. Prasso Nisi	35 52·4	27 47·0
	Khina Id., rk.	35 51 2	27 56·0
	Scarpanto I., NS 27m. S pt.	35 23 5	27 10
	Saria [2m.] mid., 1953f.	35 51	27 14
	Caxo I., EW 12m. SW pt.	35 19	26 50
	Stakida, 2 Is., [2m.] N one	35 53	26 51
	Unia Nisia	35 50	26 29
	Kamila Nisi	35 51	26 14
	Sofrana Is.	36 4·5	26 25
	Tria Nisia, Is.	36 18	26 45
	Sirna I. 1087f.	36 20 8	26 41·2
	Adelphæ Is., N one	36 25	26 38·5
	Ovo I., 170f.	35 36	25 35 5
	Candia.		
Candia ⊕	C. Krio	35 13 4	23 31·7
	Pondikonisi, 730f.	35 34 7	23 28
	Agria Grabusa, N point	35 38 6	23 34
	N extr., C. Spada, *h*, ⊥, sum.	35 41	23 43 7
	Khania, ⊞, lt F 85f.	35 30·8	24 1
	C. Tripiti	35 36 1	24 7 7
	Suda ⊞, lt. F 82f	35 28	24 9 3
	Rhitymno, lt. F 49f.	35 22	24 20 2

(36)	Places	Lat. N	Lon. E
Candia	C. Stavros	35° 25′6	24° 59′
	Megalo Kastron, ⊞, (lt. F 53f.)	35 20 6	25 9
	Standia I., summit, 870f.	35 27	25 14 2
	C. St. John, ⊞, SW 2½m.	35 20 5	25 47
	Yanisades Is., N pt., Paximada	35 23	26 11·5
	C. Sidero, lt. Rev. 138f.	35 19	26 19·7
	C. Salomon, or Plaka	35 9·2	26 19·5
	C. Zakro	35 5·2	26 17 2
	Kupho Nisi, S pt.	34 54·7	26 8 7
	Gaidaro Nisi, W pt.	34 52 3	25 41 3
	C. Littinos	34 54 7	24 45
	Mt. Ida, 8060f.	35 13 3	24 47·0
	Paximadia Is., W end, 1160f.	35 0	24 35
	Sphakia	35 12	24 8 7
	Gavdo I., 5m., lt. Rev. 1181f	34 50	24 4
	Gavdo Pulo, 1½m., 440f.	34 55·2	24 0·5
	KARAMANIA.		
Karamania	Marmorice, ⊞, Castle	36 51·1	28 19·0
	— Cape, lt F 131f.	36 43·9	28 20 7
	Karaghatch, ⊞, watering place	36 51 5	28 30·7
	Linosa I, 327f., sum	36 46·5	28 20 0
	C. Suvelah	36 35·2	28 54 0
	Makry, ⊞, theatre	36 38·1	29 9 7
	Highest sum., 5980f.	36 31 8	29 14·2
	C. Seven Capes, W pt. ⊤	36 21	29 12
	Volos I., ⊤	36 13	29 25
	Port Vathy, ⊞, sarcophagus	36 11 5	29 39
	Port Sevedo, ⊞, tank	36 10 3	29 41
	C. Roxo, Hipsili I., ⊤	36 6	29 40
	Kakava I, 4m. ⊞, W pt.	36 9·6	29 52
	Phineka Prom *h*. ⊤, S pt.	36 14·5	30 9
	Khelidonia Is. NS 2m., S islet	36 9·5	30 26 2
	Grambousa I., 1m., w′ NE part	36 13 5	30 30
	Yanar. volc.	36 24	30 30
	Mt. Takhtalo, 7800f.	36 31 7	30 28
	C. A ova, ⊥, w W-d.	36 35·4	30 38
	Adalia. ⊞, lt. F 131f.	36 52·2	30 47
	Esky Adalia, theatre, w_o, b_o	36 45 6	31 26
	C. Karabourou	36 38·0	31 43
	Alaya, $⊞_o$, SE pt.	36 31·5	32 1
	C. Anamour, ⊥	36 0·8	32 49
	Chelindreh, ⊞, w	36 9	33 22
	C. Cavaliere, ⊥, S pt. (ẇ N-d)	36 7 5	33 43·7
	Provençal I., 2m., w_o Castle, sum.	36 11 1	33 48
	Pt. Lissan al Kahbeh, *l*, shl. ¾ off, lt. F 49f.	36 14·3	33 59
	Lamas Riv., ⊤, w′	36 33 8	34 17·7
	C. Karadash, lt. F 131f.	36 32·4	35 21
	Ayas, tower on I.	36 46 1	35 48
	SYRIA.		
	Alexandretta, 2 lts. F 49f.	36 35·5	36 9·7
	Ras el Khanzir	36 19 2	33 46
	Antioch	36 12	36 8
	Ras el Bazit	35 52	35 47·5
	Ras Ibn Hani, lt. Fl. 45f.	35 35·4	35 42 5
	Latakiyah, ⊞, w, lt. F 49f.	35 30·7	35 45 5
	Ruad I., lt. Fl 92f	34 51·7	35 51
	Tripoli, Rankine I., lt. F 67f.	34 30	35 45
	Ras Beirut, lt. Fl. 125f.	33 54·2	35 28

MARITIME POSITIONS

Region	(37) Places	Lat. N	Lon. E
Syria ⊕	Damascus, Madinet-el-Arûs	33° 30′6	36° 18′5
	Mt. Hermon, sum. 9053f.	33 25·5	35 51
	Saida, Jezireh, 2 lts. F' 62f.	33 34·5	35 21·5
	Sur, 2 lts. F 56f.	33 16·7	35 11·2
	Acre, lt. F' 46f.	32 55·5	35 4
	C. Carmel Cont. lt. F, Fl. 190f.	32 49·8	34 58
	Jaffa, lt. Rev 69f.	32 2·7	34 44
	JERUSALEM, Kubbet es Sakrah, or Dome of the rock	31 46·5	35 14·7
	Ascalon, ruins	31 39·0	34 32·7
	El Arish, fort	31 6·5	33 48·0
	CYPRUS.		
Cyprus	C. Arnaut	35 6·8	32 16·2
	C. Cormachiti	35 24·7	32 55·7
	Kyrenia, lt. F 68f.	35 20	33 18·7
	N and E extr., C. St. Andrea	35 42·2	34 36·5
	Famagousta, lt. F 49f.	35 7·7	33 57·2
	C. Grego	34 56·5	34 6·5
	Larnaca, lt. F 42f.	34 55·2	33 37·7
	C. Chiti, *l*, tow.	34 49·9	33 36·2
	Limasol, lt. F 25f.	34 40·2	33 1·7
	C. Gatto, *l*	34 33·7	33 2
	C. Bianco, *h*	34 38·2	32 42·2
	C. Papho	34 44·8	32 23·7
	EGYPT.		
Egypt	Port Saïd. lt. Fl. 175f.	31 15·7	32 19·2
	Nile, Rosetta mouth	31 30·5	30 19·5
	— Damietta mouth, Kawa Burun	31 33	31 52
	Damietta, Engl. Cons.	31 24	31 48
	— lt. Rev. 180f.	31 31	31 51
	Cairo, tow. of Janissaries	30 2·1	31 15·5
	Great Pyramid, sum. (487f.) now 460f.	29 58·6	31 7·5
	Aboukir, B., Nelson I.	31 21·4	30 6
	ALEXANDRIA, ⊞, lt. R 180f.	31 11·7	29 51·7
	Arab's tower	30 59·7	29 34·7
	Ras al Kanais, pt	31 15·4	27 52
	Marsa Matroo, ⊞, w, Pt. Labeit	31 22·9	27 15·5
	Ishailah rks., E one, 58f.	31 31·3	26 38·7
	Ras Haleimah	31 37·5	26 0
	TRIPOLI.		
Tripoli	Ras al Milhr	31 53·2	25 5·7
	Tebruk, ⊞, Saracen gate	32 5	23 59·2
	Bomba, or Bhurdah I.	32 22·6	23 13·7
	Ras al Tyn, sum.	32 37·7	23 7·8
	Dernah, lt Rev. 92f.	32 46·0	22 46
	Pt. Zawani (Ras al Hilil)	32 57	22 8
	Marsa Sousa, ⊞, Arsenal	32 54·9	21 56·5
	Ras Sem	32 57	21 42·2
	Tolmeitah, pt. of the Kothoo	32 43·1	20 53·2
	Benghazi, lt. Rev. 72f.	32 6·8	20 2·7
	Gharah I.	30 47·5	19 54
	Marsa Boureigah, ruin	30 25	19 35·5
	Bouskeifa I.	30 17·5	19 9
	Ras Ben Gahouah, ruin	30 46·3	18 14
	Marsa Zafran, Port Chebek	31 12·0	16 36
	C. Misratah, Ras Torug, lt. Fl. 138f.	32 22·4	15 13·2
	Marsa Ougrah, Ras al Tabiah	32 33·5	14 26·2

Region	(38) Places	Lat. N	Lon. E
	Lebida, Citadel	32° 38′7	14° 16′5
	Ras al Tajourah, E pt.	32 53·5	13 23·2
	Tripoli, ⊞, lt. R 115f.	32 54·4	13 11·2
	Port Zouaga	32 48·5	12 27·7
	Zoarah	32 55	12 4
	TUNIS.		
Tunis ⊕	Al Biban bank, Zera spit	33 26·5	11 20
	Jerba I., Houmt-souk, lt. F	33 53·5	10 51
	Kabes Dzara pier	33 54	10 7
	Surkenis B. Nathor Tr.	34 14·2	10 3·5
	Jebel Thelj, NE sum	34 25	9 52
	Sphax, lt. F 38f.	34 44	10 46·2
	Kerkenah Is., 6/6, 9l., *l*, Ras Sinub	34 36·7	11 3·2
	— NE extr., Gzira Kebir	34 49	11 18·5
	— Banks Eastern buoy lt.	34 51·5	11 45
	Kadijah, tower, 50f.	35 14	11 10
	Mehediah, Castle	35 30·4	11 5
	Kuriat Is., lt. F 98f.	35 48·5	11 3
	Monastir, fort Ghadir	35 45·4	10 50·7
	Soussa, lt. F	35 49	10 39
	Jebel Zaghwan, 4078f.	36 21·5	10 7·2
	Hammamet Castle	36 23·3	10 37·2
	Ras Mahmur	36 27·5	10 49
	Kalibia, lt. F 269f.	36 49·7	11 8
	Ras al Asuad (*blk.* Hd.)	36 58	11 7
	C. Bon. 1290f., lt. Int. 412f.	37 5	11 2·7
	Zembra, 4/4, 2½m. sum. 1324f.	37 7·4	10 48·5
	Jebel Irsas, 2536f.	36 36	10 20·5
	Tunis, Goleta, ⊠, lt. F 39f.	36 48·5	10 18·2
	C. Carthage, lt. R 482f.	36 52·4	10 21·5
	Piana I., EW 1m., lt. F 65f.	37 10·8	10 20·2
	Cani, rks. 4/4 2m. lt. F 129f.	37 21·2	10 8·0
	Benzert, fort. lt. F 46f.	37 17	9 53
	C. Il Guerra	37 19·9	9 52·2
	Fratelli, rks. 6/6, West Rock	37 17·9	9 24·2
	Galita I., 6/6 3m. pk. Monte Guardia, 1240f.	37 31·3	8 56·2
	Sorelle, rks., Avenger reef	37 23·7	8 37·5
	ALGIERS.		
Algiers ⊕	Tabarca, N tow.	36 58·0	8 45·5
	La Cala, ⊠, lt. F 55f.	36 54·0	8 27·5
	Bona, North jetty Pt., lt. F 63f.	36 54·5	7 47
	C. de Garde, lt. F, Fl. 469f.	36 58·0	7 48·5
	Ferro I	37 5	7 20
	Ras Hadid, or C. de Fer, lt. Rev. 218f.	37 5·1	7 11
	Philippeville, 2 lts. F	36 52·8	6 53·0
	Srigina I., lt. F 180f.	36 56·3	6 53
	Collo, lt., F 33f.	37 1	6 36·5
	C. Bugaroni, (Peak 3579f.), lt. F 564f. on cape	37 5	6 29
	Marsa Zeitoun	36 57	6 14
	Jidjelli, 2 lts. F	36 50·0	5 44·7
	Mt. Babor, 6200f.	36 32·5	5 27
	Bougie, pier end, lt. F 23f.	36 44·5	5 4·2
	C. Carbon, lt. R 722f.	36 46	5 6·3
	Pisan. rks., 5/6 1m., w., W pt.	36 49·8	4 59·5
	Mt. Azafoun, 4360f.	36 50	4 25
	C. Bengut, lt. F 208f.	36 55	3 53·2
	C. Tedlès	36 55	4 9
	Dellys, pier, lt. F 33f.	36 55·5	3 55
	C. Matifou, lt. Fl. 242f.	36 48·9	3 14

MARITIME POSITIONS

	(39) Places	Lat. N	Lon. East
Algiers ⊕	Algiers, Marine I., lt. R 115f.	36° 47·3	3° 3'
	— OBSERVATORY	36 47·8	3 2·2
	C. Caxine, lt. Rev. 210f.	36 49	2 56·5
	Shershel, fort lt., F 121f.	36 36·8	2 11
	C. Tenez, lt. R 292f.	36 31	1 18
	Palomos I., rk. ⌒, 85f.	36 26·3	0 55·7
	Mostaghanem, lt. F 115f.	35 56·3	0 4·5
			West
	Arzeu I., lt. F 66f.	35 52·5	0 17·7
	C. Ferrat, ⊥, *h*, lesser sum.	35 54·3	0 23·5
	Pt. Abuja, 2050f., pt.	35 53	0 29
	Oran Marsa el Kebir, lt. F 121f.	35 44·3	0 41·7
	C. Falcon, *l*. δ, lt. Rev. 340f.	35 46·4	0 47·2
	Habibas Is., 3m. w., sum. lt. F 340f.	35 43	1 8
	MOROCCO.		
Morocco	Zafarine Is., EW 1¼ m. W ext. sum. 441f., lt. F	35 11·0	2 25·7
	Melilla	35 18·3	2 57·0
	C. Tres Forcas, N pt. mid	35 27	2 59
	Alboran I., 1m., lt. F 115f.	35 58	3 2
	C. Quillates	35 10·5	3 45·5
	Mostaza	35 9·7	4 26·5
	Tetuan, Custom-ho.	35 37	5 18
	Ceuta, lt. R 590f.	35 53·6	5 17
	Tangier, Battery, lt. F 58f.	35 47·2	5 48·2
	ATLANTIC OCEAN.		
	Madeiras.		
Madeiras	Porto Santo, 7m., 1660f.	33 5·0	16 19·5
	Styx, rks. NW of P. Santo	33 11	16 24
	Desertas, 12m. sum. 1610f.	32 31·3	10 30·7
	— S. or Agulha pt	32 23	16 27
	Madeira, EW. 30m., E pt., lt. F, Fl. 343f.	32 43·4	16 39·5
	FUNCHAL, BRIT. CONS.	32 38·3	16 54·5
	— PONTINHA, lt. F 112f.	32 37·7	16 55
	Pico Ruivo, 6100f.	32 45·0	16 57·0
	West, or Pargo pt.	32 48	17 17
	Salvages, 2 grps., 15m. NE breaker	30 8·6	15 49·7
	Great Salvage, 1¼m., W sum.	30 7·5	15 51·2
	Great Piton, 3m., sum.	30 1·0	16 0·2
	Canaries.		
Canaries	Alegranza, 2½m., 939f., Pt. Delgado, lt. R 57f.	29 24	13 29
	Clara, 1m., N pt.	29 18·0	13 32·2
	Graciosa, 5m. w., SW pt.	29 12·7	13 32·7
	East rock, [3c.]	29 16·4	13 20·0
	Lanzarote, 32m., NW pt.	29 2·7	13 48·0
	— S pt.	28 50·0	13 47·0
	— Arecife (Port Naos, fort Gabriel, 2 lts. F 47 & 35f.	28 57·0	13 32·5
	Lobos I., 2m., N pt., lt. F 95f.	28 45·5	13 48·5
	Fuerteventura, 53m., NW pt	28 42	14 1
	— Port Cabras	28 29	13 51·7
	— S pt. or Pt. Jandia, *l*, lt. Rev. 108f.	28 3·0	14 32

	(40) Places	Lat. N	Lon. W
Canaries	Grand Canary, NS 25m., NW pt.	28° 9·6	15° 43·2
	— Palmas, mole head, lt F 25f.	28 7·0	15 25
	— Maspalomas pt., lt. F 190f.	27 43·8	15 34
	— Isleta, 2m., lt. F, Fl. 817f.	28 11·0	15 25·5
	Tenerife I., N pt., Anaga rk.	28 36·6	16 8·5
	— Sta. Cruz, Brit. Consul. w'''	28 28·2	16 14·7
	— S pt. or Pt. Rasca	28 0·0	16 41·2
	— Peak, 12,172f.	28 16·5	16 39·0
	— W extr., *l*	28 20·5	16 55
	— Orotava, port	28 25·2	16 32·0
	Gomera, EW 14m., W pt.	28 6·5	17 20·5
	— Sum. 1440f.	28 6·7	17 13·5
	Hierro, or Ferro, 15m. N extr.	27 50·5	17 55
	— W extr., Orchilla pt. (or *Meridian of Ferro*)	27 42·5	18 10
	Palma, Cumplida Pt., lt. R 207f.	28 50	17 47
	— S pt. or Fuencaliente	28 26·7	17 49·7
	— Sta. Cruz, fort San Miguel	28 40·5	17 44·5
	Azores.		
Azores	Corvo, 4m., w, N pt.	39 43·5	31 7·2
	Flores, NS 9m., N extr.	39 31·6	31 13·0
	— Sta. Cruz, fort	39 27·0	31 8·0
	Fayal, 11m., W pt.	38 35·6	28 50·5
	— Horta, Sta. Cruz, castle, lt. F 28f.	38 31·7	28 38·5
	Pico, 25m., Pk. 8400f. ?	38 28·0	28 25·0
	— E pt.	38 24·7	28 3·0
	St. George, 29m., S and E pt.	38 32·5	27 46·7
	— N and W pt. outer rk.	38 45·2	28 20·2
	Graciosa, 7m., W. pt.	39 4·2	28 4·7
	— Praya, castle	39 3·2	27 58·5
	Tercera, EW 16m. Praya	38 43·7	27 4·2
	— Angra, Custom ho.	38 38·9	27 13·7
	— Sum. 3495f.	38 43·5	27 20·5
	St. Miguel, r, E or Arnel pt., F, Fl, 219f.	37 49	25 8·2
	— Delgada, lt. F 20f., Custom-ho. quay	37 44·2	25 40·7
	— West pt. or Pt. Ferraria, lt. bad	37 51·7	25 52·2
	St. Mary I., 9m., town	36 56·6	25 9·5
	— mid., sum. 1660f.	36 58·5	25 6·2
	Formigas, NS ¾m., 60f.	37 16·2	24 47·5
	Dollabarats shl. [1c.], 11f. δ	37 13·7	24 44·5
	Cape Verdes.		
Cape Verde Islands	St. Antonio, 22m. N pt., lt. F 23f.	17 12·0	25 5·7
	— West pt.	17 4·0	25 22·5
	— Sum. 7400f.	17 4	25 17
	— Tarafal B. wat. place	16 57·2	25 10·0
	— South pt.	16 54·7	25 18·5
	— NE, Bull pt., lt. F, Fl. 543f.	17 7	24 59·0
	St. Vincent, EW 16m., S pt.	16 47·0	24 59·0
	— PORTO GRANDE, Bird I., lt. F 306f.	16 51·7	25 0·7
	— FLAGSTAFF OF TELEGRAPH OFFICE	16 53·3	24 59·5
	St. Lucia, 7m., N pt.	16 49·0	24 47·0
	— Village, ruins, SW side, w.	16 45·0	24 45·5
	Branca, 3m., N pt.	16 41·0	24 41·5

MARITIME POSITIONS

(41)	Places	Lat. N	Lon. W
Cape Verde Islands	Raza, *l*, T, EW 2m., mid	16°38′	24°37′
	St. Nicolas, 6/5 25m., N pt	16 42·0	24 20·5
	— East pt.	16 34·5	24 0
	— South pt.	16 28	24 18·5
	— West pt.	16 37·7	24 26·2
	Sal, NS 17m., N pt.	16 51·0	22 55·0
	— NW hill	16 48·0	22 57·5
	— Martinez Pk, 1340f.	16 49	22 56
	— Wreck, or SE pt.	16 35·0	22 53·5
	— South pt.	16 34	22 57
	Bonavista, EW 18m., N rf. and pt.	16 14	22 57
	— Hartwell rf., δ, NE pt	16 11	22 41
	— East extr. or Sandhead, outer rk.	16 7	22 40
	— South pt. (rks.)	15 57·0	22 49·5
	— English road, Small I., lt. F 91f.	16 9	22 57
	— New town, ch.	16 7·6	22 55·5
	Leton rks., [1m.], rf, δ, r̄	15 48	23 10
	Mayo, NS 12m., N rf., N and E pt.	15 20	23 11
	— North pt.	15 19·0	23 12·0
	— South pt.	15 6·5	23 10·5
	— English town, Fort San Jose, lt. F 62f.	15 7	23 13·2
	St. Jago, 2/2 31m., E pt.	15 1	23 26
	— Port Praya, Temerosa pt., lt. F 85f.	14 53·0	23 30·7
	— Mt. St. Antonio, 7400f. ?	15 2	23 39
	— West pt., extr.	15 17·3	23 48
	— North, or Bighude pt.	15 19·0	23 46·0
	Fogo, EW 15m., N pt.	15 1·5	24 21·5
	— Fort Carlotta, lt. F 116f.	14 52·0	24 30·5
	— Peak, 9760f	14 56	24 20
	Brava, NS 6m., W pt.	14 49·7	24 45·2
	— South pt.	14 46	24 42·7
	— Two Islets, EW 5m., W extr.	14 57	24 43
	BERMUDAS.		
Bermudas	Mount hill, lt. F 208f.	32 21·7	64 38·7
	North rk.	32 28·4	64 47·7
	West extr. of reefs	32 16	65 3
	South extr. of reefs	32 12	64 52
	Dockyard, clock [b] ⊕	32 19·4	64 51·5
	Wreck hill	32 16·7	64 54·7
	Gibbs Hill, lt. Rev. 362f.	32 15	64 51·5
	Region of Submarine Volcanoes	7 0N to 1 0S	16 0 to 24 0
	Penedo de San Pedro, or St. Paul's rks, [¼m.], L₀, mid. rk., 60f.	0 55·5	29 22·5
	AFRICA, N.W. Coast.		
	C. Spartel, lt. F 312f.	35 47·2	5 55·7
	Mt. Habile, 3000f.	35 28	5 43
	Araish, w′	35 12·8	6 9
	Jebel Sarsar, or pk. of Fas	34 54	5 47
	Mehedia, 456f.	34 18	6 30
	Sallee, [I]	34 2·7	6 46
	C. Dar el Beida	33 38	7 36
	Azamor, 120f r	33 18	8 15

(42)	Places	Lat. N	Lon. W
Africa, North-West Coast	Mazagan, w′, r′	33°15′	8°29′
	North C. Blanco, 170f.	33 8	8 38
	C. Cantin, ⊥, 211f. (rks. off)	32 32·5	9 21
	Safi, Mosque, 209f., ẇ	32 18	9 12
	Jebel Hadid, SW sum. 2100f., tomb	31 42	9 29
	Mogador, or Souirah, [I], w r	31 30·5	9 46·2
	C. Tefelneh, 700f. pt.	31 6	9 48
	C. Ghir, ⊥, 1235f. pt.	30 38	9 50
	Mt. sum. E of C. Ghir, 4400f	30 39	9 33
	Sta. Cruz, or Agadir, r̄	30 26	9 32
	R. Sous, bar	30 22	9 30
	Macas, or Messa R., Castle	30 4	9 38
	Cleaveland Shl. ?	30 45	10 21
	Fogo Pk., 2970f.	29 11	10 6
	C. Noun, ⊥, T, 170f. ○	28 46	11 3
	R. Noun, or Soleiman ?	28 42	11 5
	Port Cansado, β, entr.	28 2	12 14
	C. Juby, *l*, [✻]	27 58	12 52
	False C. Bojador	26 25	14 12
	C. Bojador, *l*, W pt.	26 7·0	14 29
	Penha Grande, 300f.	25 7	14 50
	C. Seven Capes, Central C.	24 41	15 0
	Durnford Pt., entr R. Ouro, [I]	23 36·0	15 58·0
	Down of Cintra, or peaked sand hill, w̄	23 5	16 10
	C. Barbas, ⊥	22 19·5	16 45
	C. Blanco, ⊥, 150f., (w̄ N-d.) (δ SW-d. 5m.)	20 46·5	17 4
	Arguin bk. (lim. of δ, s̄), N extr.	20 33	16 56
	— West extr.	20 6	17 7
	— South extr.	19 17	16 32
	C. Mirik, *l*, δ 2 or 3 l. off	19 24	16 32
	Portendik, w₀, P₀ 2 ⳨ near	18 19	16 2
	Mosquito Lagoon ⊖	16 35	16 30
	Barbarie Pt.	16 55	16 34
	Senegal, [I], St. Louis, (bar, δ), fort fl. st., and lt. F	16 0·8	16 31·0
Senegambia	C. Verde, C. Almadie, lt F 85f.	14 44·5	17 32·7
	— Paps, lt. R 371f.	14 43	17 31
	C. Manuel, lt. F 171f.	14 38·6	17 27
	Goree I., 2/2 4c, [b], fl. st., fort	14 39·9	17 24·5
	Amboroo bk., W pt., ⳨	14 16	17 3
	Bird I., 2 2m., Pilots, fl. st.	13 39·5	16 40·5
	R. Gambia, [⚓], [b], Bath. fl. st.	13 28·0	16 35·0
	C. St. Mary, *l*	13 30	16 41
	Bald Cape (Is. 4m. W-d.)	13 23	16 50
	Casamanza R., lt. F 52f.	12 35·5	16 44
	C. Roxo, *l*, Sand hill, ⳨	12 20	16 46
	Falulo breakers, 6/5 3m., T, W pt.	12 10	16 44
	Fort Cacheo, Portug. Settlem.	12 17·7	16 13
	Cayo Is., *l*, T, ⳨, S pt.	11 50	16 22
	Bissao, [⚓], w, r	11 52	15 37
	Bijouga Is. P,, W extr. breaker 30m, out.	11 30	16 58
	— South breaker	10 40	16 8
	Pullam I. [1m], *l*, ⳨, (rfs., SW 8m.)	10 52	15 43
	Alcatraz reefs, 4/4 7m., NE Id. ~	10 37	15 21
	Conflict rfs., S and E prong	10 22	15 4
	Rocky Head, 2	10 6	15 6
	Rio Nunez, ẇ, P,, Sandy I.	10 36·6	14 42
	C. Verga, pt. *l*	10 12	14 28
	Mt. Kakulimah, 2900f.	9 45·8	13 28

MARITIME POSITIONS

Region	(43) Places	Lat. N	Lon.
			West
Sierra Leone	Is. de Los EW 6m, w', r, Crawford Id., Engl. Estab	9°27'4	13°48'5
Sierra Leone	— W one, Tamara I., 8 l. T, ⚓' E. W pt.	9 28	13 52
Sierra Leone	Sallahtook Pt.	9 4	13 20
Sierra Leone	Yellaboi I., EW 2m., ⚓, W cliff	8 57·0	13 18·5
Sierra Leone	C. Sierra Leone, lt. F, Fl. 75f. [b]	8 30·0	13 18·5
Sierra Leone	Freetown, N battery	8 29·9	13 14·5
Sierra Leone	False C. Sierr. L.	8 26	13 18
Sierra Leone	C. Shilling, l, ⚓, sum over ...	8 10	13 10
Sierra Leone	Bananas Is., [illegible] 5m., w, Gov. ho.	8 8·0	13 11·7
Sierra Leone	Plaintain Is., EW 5m., outer rk	7 54	13 3
Sierra Leone	Shls of St. Ann, NW patches	7 58	13 34
Sierra Leone	Turtle Is., l, N Id., [½m.]	7 40	13 4
Sierra Leone	Sherboro I., W pt., or C. St. Ann, ⚓	7 34	12 58
Sierra Leone	R. Shebar, E entr., or Man t Pt.	7 23	12 31
Sierra Leone	R. Gallinas, Kamasoun I. [1m.], W elbow	7 0·1	11 38·7
Liberia	C. Mount Riv., town	6 45	11 23
Liberia	C. Mount, w, pk., 1060f.	6 43	11 21
Liberia	C. Mesurado, 8 l. ⚓, w, lt. F 240f.	6 19	10 50
Liberia	Monrovia, Govt. ho.	6 19·1	10 49·0
Liberia	Marshall, Agent's ho.	6 8·1	10 22·7
Liberia	Grand Bassa, Amer. Agent's ho.	5 54·1	10 4·0
Liberia	Tabocannee rk	5 48	10 1
Grain Coast	Trade Town	5 44	9 54
Grain Coast	Mt. Tobacco, 830f.	5 47	9 44
Grain Coast	Cestos, factory	5 26·4	9 34·7
Grain Coast	R. Sanguin, r, b, Pt. Sanguin	5 12·7	9 20·2
Grain Coast	Bloobarra pt.	4 59·2	9 2·0
Grain Coast	Settra Kroo	4 54	8 50
Grain Coast	King William Town, Europ. factories	4 49	8 43
Grain Coast	Coley rk ...	4 23	7 54
	Gulf of Guinea.		
Ivory Coast	C. Palmas, lt. F	4 22·1	7 44·2
Ivory Coast	Tafou pt.	4 24·8	7 21·5
Ivory Coast	Kadabboo bluff	4 39	6 54
Ivory Coast	Oval Mountain, 1315f	4 57	6 48
Ivory Coast	King George Town	4 58	6 3
Ivory Coast	C. Lahou	5 11	4 31
Ivory Coast	Head of the Bottomless Pit, 100	5 15	3 57
Ivory Coast	Assini R., entr. bar, 11f.	5 8·6	3 23
Ivory Coast	Apollonia (abandoned)	4 59	2 35
Gold Coast	Axim, Dutch fort	4 52·3	2 14·7
Gold Coast	C. Three Pts., δ 2m, lt. F 75f.	4 44·7	2 5·7
Gold Coast	Dix Cove, f, fort	4 47·8	1 56·7
Gold Coast	Elmina, Dutch fort	5 4·8	1 22·2
Gold Coast	C. Coast Castle, lt. F on Fort William, 192f.	5 6	1 13·7
Gold Coast	Accra, Fort James, [illegible], lt. F 50f.	5 31·8	0 11·5
Gold Coast	Camel's Hump, 1200f.	5 37	0 31
			East
Gold Coast	R. Volta, W pt., l, entr.	5 46·0	0 41·2
Gold Coast	C. St. Paul, l (no distinct cape), ⚓	5 50	0 58
Gold Coast	Jella Coffee	5 52	1 0
Gold Coast	Quitta Danish, r, SE bast.	5 55·1	0 59·7
Gold Coast	Little Popo, w, [illegible], NW shed	6 13·6	1 36·2
Gold Coast	Grt. Popo (bar. δ)	6 16	1 54
Gold Coast	Whydah, fl st.	6 18·9	2 5·0

Region	(44) Places	Lat.	Lon.
		North	East
Bight of Benin	Porto Novo (no port)	6°23'	2°35'
Bight of Benin	Badagry, shore hut	6 24·2	2 53·2
Bight of Benin	Lagos, entr. [⅓m] bar 6 f., lt. F 70f.	6 24	3 27
Bight of Benin	Oddy Sand beach	6 20	4 31·7
Bight of Benin	R. Benin, bar 12f. NW pt.	5 46·0	5 4
Bight of Benin	R. Forcados, entr. S pt.	5 22·0	5 19·2
Bight of Benin	R. Quorra, or Niger, E pt	4 17	6 4
Bight of Benin	C. Formosa, l, ⚓ (no distinct cape)	4 15	6 11
Bight of Benin	New Calebar R., entr 18f., W pt	4 23	7 1
Bight of Benin	Bonny R., entr. 18f, E pt, T, r, rough corner	4 23	7 8
Bight of Biafra	Old Calebar, Tom Shot's Pt.	4 36	8 19
Bight of Biafra	Mt. Cameroons, 13760f.	4 13	9 12
Bight of Biafra	Cape Cameroons	3 55	9 30
Bight of Biafra	Rumby Mountains, sum	4 57	9 18
Bight of Biafra	Qua Mount., 25 l.	5 15	8 51
Bight of Biafra	Ambas B., Mondoleh I. [½m.] h. ⚓, w, S pt.	3 58·7	9 12·5
Bight of Biafra	Suellaba pt. (rf. 3m. off)	3 51	9 35
Bight of Biafra	The Mitre, 3940f., S sum	1 20	9 57
Bight of Biafra	C. St John, ⚓	1 9·7	9 22
Bight of Biafra	Corisco I., l, ⚓	0 55·9	9 20
Bight of Biafra	C. Esteiras	0 38	9 21
Bight of Biafra	Gaboon R., r w, Libreville, lt. F	0 23	9 26
Bight of Biafra	King George Town	0 8	9 44
Islands in the Bight of Biafra	Fernando Po, [illegible] 40m., δ 3m. C. Bullen, or N pt.	3 48	8 43
Islands in the Bight of Biafra	— Peak, 10710f.	3 35	8 47
Islands in the Bight of Biafra	— S. pt., or C. Barrow	3 13	8 43
Islands in the Bight of Biafra	— Clarence Cove, w', b, Adelaide islet [b], lt. F	3 46·0	8 47·5
Islands in the Bight of Biafra	Princes I., NS 9m. N rk. off	1 43	7 23
Islands in the Bight of Biafra	— St. Antonio B., fort Sta. Anna	1 39·5	7 26·5
Islands in the Bight of Biafra	Brothers, 2 Is., NS 2½m., S one	1 21·1	7 17·5
Islands in the Bight of Biafra	St. Thomas I., [illegible] 25m. sum. 7020f.	0 14·7	6 33
Islands in the Bight of Biafra	— Sta. Anna de Chaves, fort St. Sebast., lt. F 35f.	0 20·5	6 43
		South	
Islands in the Bight of Biafra	— Ilha das Rollas [1m.] off S. pt.	0 0·5	6 30
Islands in the Bight of Biafra	Annobona, [illegible] 4m., δ ... Turtle I., [1m.], ⚓, w, r	1 24·3	5 38·2
Islands in the Bight of Biafra	— S extr., rk. off	1 28·6	5 36·7
	ISLANDS IN SOUTH ATLANTIC.		West
	Ascension, EW 7½m, Fort Thornton, lt. F. [b]	7 55	14 25
	Green Mtn., 2820f	7 57	14 21
	Cross Hill, 850f. on with Gr. Mt., S 71° E	7 55·7	14 25·0
	St. Helena, [illegible] 9m., Diana's pk. 2700f.	15 57	5 40·5
	OBSERVATORY, 1h G.M.T.	15 55·4	5 42·5
	Fernando Noronha, Is., [illegible] 6m., S and W. extr. pt.	3 52	32 28
	— peak, on SE side	3 50·4	32 25·5
	Rocas [4m.], rf NW end	3 51·5	33 49

MARITIME POSITIONS

(45) Places	Lat. S	Lon.
		West
Trinidad I., $\frac{a}{4}$ 4m., 2020f. S. pt.	20° 31′	29° 19′
Martin Vas. 3 Is., NS 1½m. ...	20 28	28 51
Tristan d'Acunha, [6m.] Waterfall, N side	37 2·7	12 18·5
Inaccessible Is., 16 l., ⌒, ⌊, w, W one	37 17	12 36
Nightingale I. [2m.]	37 27	12 29
Gough's I. [5m.], 4385f., N pt. .... ⊖	40 19	9 44
AFRICA, West Coast.		
		East
Nazareth R., Fetish town, W entr.	0 37	9 1
C. Lopez, *l*, ⊤, r̄	0 36·0	8 43
C. St. Catherine, [✝]	1 51	9 6
Settee R., a high ✝	2 23	9 26
Mayumba B., r̄, Matooti Pt....	3 22·7	10 38
Loango R., entr.	4 39·5	11 45
Black Pt., B, [✝], w‴, Sandy Pt., *l*. .... ⊖	4 49	11 46
Lendana Pt., lt. F 111f.	5 11	12 8
Kabenda Pt., lt. F 50f.	5 32	12 11
Congo R., P., Pt. Padron	6 8	12 13
— S. entr., or Shark's Pt, ⊤, δ_o 2c.	6 4 6	12 17
Foreland bluff, lt. F 78f.	7 15	12 53
Ambriz, ⚓ ,,, lt. F	7 52	13 8
Dandé Pt. and riv.	8 28	13 19
C. Lagostas, rks., lt. F, Fl. 210f.	8 46·1	13 17·5
St. Paul de Loando, ⊞, [b]. fl. st. [b]	8 48·3	13 13
Palmairinhas Pt., lt. F, Fl. 57f.	9 4	13 0
C. Ledo, *h*, ✝, pt.	9 46	13 17
C. St. Bras, ⊠, r̄.	10 1	13 22
Nova Redonda, r, w_o ⌊, ...	11 12	13 54
Quicombo B., β 1m. out, w,, S pt. .... ⊖	11 20	13 48
St. Philip de Benguela, r̄, w,, St. Philip's Bonnet, lt. F 394f.	12 33·9	13 18
Logito R., w‴ r	11 58·5	13 46
Lobito, ⊞, r̄, ww$_o$, pt.	12 20	13 32
Salinas Pt., *l*, ✝ at pt., lt. F, ⊖	12 53	12 59
Elephant B., ⊞, B, r̄ ww$_o$, Monks, or Friars, rks. 12 or 14f. .... ⊖	13 14	12 42 7
C. St. Mary, ⊤, w_o .... ⊖	13 25	12 33
Little Fish B., Ponta do Giraul, lt. F 64f.	15 9	12 12
C. Negro, 200f., *l* pt., Diaz's Pillar	15 40·7	11 58
Port Alexander, ⊞, r̄ w̄	15 46	12 0
Great Fish B., w, 1″, Tiger Pt., ⊤, δ_o 2c.	16 30·2	11 46
Nourse R. (temporary) ...... ○	17 25	11 54
C. Frio	18 23	12 2
C. Cross (or Sierra)	21 50	13 57
Mt. Colquhoun, 17 or 18 l. ... ⊖	22 32	– –
Walvisch B., ⊞, r̄ w$_o$, factory, lt. F 24f.	22 57	14 30
Port Sandwich, or d'Ilheo, ⊠, r ⚓ ,,, ...	23 30	14 25
Hollam's Bird I. [2c.], rf. SW 5m., ⌒, ⌊, ...	24 37·4	14 32

West Coast of Africa

(46) Places	Lat. S	Lon. E
Mercury I. [⅓m.] .... ○	25° 46′	15° 0′
Angra Pequena, r̄, w N 10m., SW or Pedestal Pt.	26 38·4	15 8
Seal I. [1m.], w_o	26 34	15 14
Possession I., $\frac{a}{12}$ 3m., rfs. off, w_o, S pt. .... ○	26 58	15 13
Arched rk., 100f. .... ⊖	27 20	15 19
Orange R., ⌒, bar	28 38	16 28
C. Voltas, w̄, ...	28 44	16 32
Koussie R. .... ○	29 40	17 10
CAPE COLONY.		
Olifant's R., or Elephant's R. ‖$_o$	31 38	18 12
C. Donkin	31 54·2	18 19
C. Deseada, ⊥, *h*	32 18	18 23
Berg R., entr. (w′ 5m. up) ...	32 45	18 13
Britannia rk.	32 38	17 41
St. Helena B., Pt. St. Martin, *l*	32 40	17 59
Pt. Paternoster, or W pt.	32 42·2	17 54·2
Sunken rock ?	32 51	17 46
Saldanha B., r̄, r, w, Ship rk., at N pt.	33 1·7	17 54
— Houtjes B., ⊞, Hout. pt....	33 0 1	17 58 0
— Schapen I., w′, W pt.	33 4·2	18 1·0
Dassen I., $\frac{a}{4}$ 2m., *l*, ⌒, w_o, β 2m., cent.	33 26·2	18 6·7
Bock Pt.	33 33 8	18 19
Robben I., $\frac{a}{12}$ 1½m., lt. F 154f.	33 49·2	18 22
Table B., Green Pt., lt. F 65 ft. [b]	33 54 2	18 24·5
Devil's Peak, 3270f.	33 57 2	18 26·7
CAPE OBSERVATORY, ♦ 1ʰ G.M.T. 11ʰ 46ᵐ 5ˢ	33 56·0	18 28 7
Cape of Good Hope, lt. Rev. 816f.	34 21·2	18 29·5
Bellow's rk.	34 23	18 29 7
Simon's B., Dk. yd.	34 11·3	18 26 0
C. Hangklip	34 23·2	18 49·5
Danger Pt., *l*, rks. 2m. bluff ..	34 37·8	19 17·7
Quoin Pt.	34 46·8	19 38 5
C. Agulhas, S extr. of Africa, lt. F 128f.	34 49·7	20 0·7
Pt. Struys, δ 3m.	34 41·4	20 14·2
C. Infanta, S pt., Sebastian B.	34 28·4	20 51
C. Barracouta	34 26·4	21 18·4
C. Vacca	34 19·7	21 55
Flesh Pt.	34 17·7	21 57·0
C. St. Blaize, lt. Fr 240f.	34 11 2	22 9 5
Knysna R., ⊠, entr. ⊥	34 5	23 3 7
Plettenburg B., w, r, r̄, S pt. or Seal C.	34 6·5	23 25
C. St. Francis, rf., β, ⊤, lt. Fl. 118f.	34 11·6	24 50
C. Recif, *l*, lt. Rev. 93f. (rf. 4m.)	34 1·7	25 42·2
Algoa B., Port Elizabeth, lt. F 225f.	33 57·7	25 37·7
Bird Is., $\frac{a}{6}$ 3m., E pt. lt. F 80f.	33 50·5	26 17·2
Pt. Padron	33 46·5	26 28
Kowie R., entr. Port Alfred, lt. F 40f.	33 36	26 54·2
Grt. Fish Pt.	33 31·4	27 7
———R., entr.	33 29 6	27 8·5
Keiskama, R., entr. W pt......	33 16·7	27 29·5
Cove rks., centre	33 5·1	27 49·2
Buffalo R., East London, F 45f.	33 1 7	27 55·0
C Morgan	32 42 1	28 24·7
Hole in the Wall	32 3·2	29 1·0

Cape Colony ⊕

MARITIME POSITIONS

	(47) Places	Lat. S	Lon. E
Kafferland	Rame Head	31° 48′·4	29° 14′·5
	St. John's R., entr.	31 34·5	29 28·7
	C. Natal	29 53·0	31 2·2
	Port Natal, ⚓, bar δ, S pt. of bay, lt. Rev. 282f.	29 53	31 4
	Fisher's R.	29 16·3	31 33
	Durnf·rd Pt.	29 0·2	21 51·5
	C. St. Lucia	28 32·5	32 27·5
	St. Lucia R., entr.	28 26·0	32 26·5
	C. Vidal	28 9·6	32 38·0
	Goldown's Blind river	26 55	32 53
	AFRICA, East Coast.		
East Coast of Africa	Delagoa B., C. Collato, 260f.	26 4·0	32 58
	— C. Inyack, N pt. of St. Mary I., 265f.	25 58·0	33 0
	Port Melville, Elephant I., w SW side, Gibbon Bn pt.	25 58	32 54·2
	English R., Reuben pt., lt. F 134f.	25 58·8	32 36
	Innampura R., entr.	25 11·6	33 31·5
	Pt. Zavora R.	24 28·5	35 12·5
	C. Corrientes, 11 L., small rk., 15f.	24 5·5	35 30·5
	Barrow Hill, Burra, lt. F 80f.	23 45·5	35 32·2
	Innamban B., ⚓, town	23 49·5	35 3·5
	C. Lady Grey, 95f.	22 55	35 36·5
	C. St. Sebastian, 10 L., pt. 225f.	22 6	35 29
	Bazarouta Is., N pt., or C. Bazarouta, 390f.	21 31·0	35 28·0
	Inverarity shl., Mi-adjuano	20 42	35 10
	Chinwan I. [5m.], *l*, ⚓, Singune, lt. F 36f.	20 38·2	34 53·5
	Sofala R., bar. 12f. fort	20 10·7	34 43
	Pungue R., Beira, lt. red	19 50·2	34 50·5
	Zambesi R., Kongoni R. mouth, lt. 85f.	18 53	36 11·7
	Kiliman R., bar 9f., *l*, ⚓, Pt. Tagalane, lt. F 52f.	18 1·4	36 57
	Acorn rk.	17 37	38 13·5
	Primeira Is., Casuarina, or Raza I., ⚓ W, w, b	17 6·5	39 4
	Mt. Cockburn	16 29	38 56
	Angoche Is., Wst., or Moma bk. [1m.]	16 47	39 32
	— Mafamede I., *l*, ⚓, rfs., cent.	16 20·5	40 2
	— R., Custom ho.	16 13	39 56·5
	St. Antonio, R., S pt., rf. [2m.]	15 57	40 9
	Huddart's shl.	15 47	40 26
	Mozinkwah R., Funco pt.	15 32	40 29
	Port Mocamba, N pt., entr., T, ⚓, pk., ab. 2000f.	15 8	40 35
	Mozambique, ⚓, Sebastian Fort fl. staff, lt. F. green 42f.	15 0·7	40 44·7
	Mt. Pao	14 50	40 25
	Mount Meza, 1005f	14 43	40 38
	Titangonya I., 2m., S pt.	14 51·0	40 50·0
	C. Melamo	14 25·0	40 50
	Penda shl., E extr.	14 15·0	40 50·0
	Loguno Peak	14 21·0	40 35
	Sorisa Pt	13 32·8	40 35·2
	Manobané Pt.	12 58	40 36

	(48) Places	Lat. S	Lon. E
Mozambique	Pomba Bay, ⚓, N pt., entr., T	12° 55′·8	40° 31′·2
	Arimba Head	12 38·2	40 39·0
	Ibo I., $\frac{4}{4}$ 5m., Ibo Bluff, lt. F 51f.	12 20·0	40 38·5
	Mahato I., $\frac{4}{4}$ 2m., N and E pt.	11 58·2	40 36·2
	I. dos Mattos, [½m.], rfs. 2m. out	11 49	40 37
	Fungu Namegno, E. pt. of reef	11 28·5	40 40·7
	Tambuzi I., EW 2m., rfs. 2m., w′	11 21·3	40 41
	Mazimba, fort	11 18·5	40 22·5
	Numba I., $\frac{4}{4}$ 3m., E pt.	11 9·5	40 42·2
	Rongwi I., E pt.	10 51	40 41·5
	C. Delgado, pt., lt. F 59f.	10 41·3	40 39
	C. Rovouma	10 28·7	40 31·5
	Matunda Pt.	10 21	40 27·2
	C. Paman, Hull rk.	10 11·5	40 9
	Mikindani Hr. Kinzi Vill.	10 16·5	40 7·5
	Mngulho R., b, ẇ, Madjovi Rks.	10 6·7	39 59
	MADAGASCAR.		
Madagascar	S extr., C. St. Mary	25 38·9	45 5·0
	Star bk., SW part, 27	25 39	45 21
	Star reefs, NS 3 l., T W, S one	25 25	44 16
	Leven I., [½m.], centre	25 12·5	44 16·0
	Barracouta I., [½m.]	25 3·0	44 5·5
	St. Augustine B., Tent rk.	23 35·4	43 43·7
	Noss Veh, or Sandy I.	23 38·4	43 30
	Murderer's Bay, N pt.	22 12·5	43 16·0
	Murder I., rf. 2m., SW	22 5·3	43 13·5
	C. St. Vincent	21 52·5	43 18·5
	Monrondava, w, r, *T*	20 18·3	44 17·5
	Barren Is., *l*, ⚓, S danger	18 41	44 1
	— Smyth's islet, on rf. $\frac{16}{5}$ 2½m.	18 18·1	43 44·7
	Coffin I., *l*, (δ 2 l.)	17 29·0	43 45·2
	NW extr., C. St. Andrew	16 11·4	44 29
	Chesterfield bk. [¼m.], *T*	16 17	43 53
	Boyanna B., W er Table C.	15 59·0	45 16
	Bembatooka B., ⚓, r, E or Majunga Pt.	15 42·9	46 18·5
	Makumba I.	15 42·0	45 55·7
	Majambo B., ⚓, entr. W pt.	15 11·7	46 57·5
	Nareenda B., ⚓, entr. W pt.	14 40·3	47 24·5
	Luza R., bar 2, ⚓, entr.	14 36·9	47 41·0
	Sancassee I., NS 4½m., N pt.	14 32·7	47 33·2
	M·Cluer Pt.	14 15·0	47 47·2
	Erandza I., NS 2m., N pt.	13 53·5	47 45
	Passandava B., Nucpin I., lt. F 184f.	13 28·2	48 13·0
	Passage I., [½m.]	13 28·2	48 27·7
	Dalrymple B., ⚓, r, ẇ, b, entr	13 30	48 0
	Martahoolah Pk.	14 6	48 18
	Noss Beh I., NS 13m., N pt.	13 12·2	48 16·7
	Minow I., N. pt.	12 49·5	48 37·0
	C. St. Sebastian (Is. 5m. off), pt.	12 27·7	48 43·7
	Woody I., [¼m.]	12 16·7	48 39·2
	Port Liverpool, ⚓, entr. N pt.	12 3·3	49 9·5
	N extr., C. Amber	11 57·5	49 17·0
	Amber Mountain	12 34·5	49 9
	British Sound, ⚓, entr., Clarence Id.	12 13·8	49 21·5
	C. Lowry	12 35·0	49 37·7
	Porte Looké, ⚓, Bathurst Pt	12 44·2	49 45·0

MARITIME POSITIONS

(49) Places	Lat. S	Lon. E
Madagascar, E. Coast ⊖		
Port Leven, ⊞ Lingo rk	12°46′·5	49°53′·2
Noshe Barraconta, [1m.]	12 48	49 55
Andrava B., Berry Hd	12 56·8	49 54·5
Manambatoo Vill., ‡,	13 14·4	49 56·5
Vohemar Pt.	13 23·5	50 1·2
Mananhar, Table Hill	14 39·7	50 13·7
C. East, outer I.	15 15·8	50 29·5
Durnford Noss, pt.	16 0·0	50 9·5
Port Choiseul, town	15 27·3	49 50·2
C. Ballones, pt.	16 14·0	49 52·0
Tangtang, ⊞, fl. st.	16 42·5	49 44·2
St. Mary's I., $\frac{1}{2}$ 11 l., N. pt.	16 40·5	50 2·7
— I. Madame, or Quail I., on W side, Establ., lt. F 31f.	17 0·0	49 52·0
Fenerive, town	17 23·0	49 26·2
Foule Pt. Vill., r, ꜔	17 40·4	49 33·2
Prune I., vis. 5l., ⚓	18 4	49 30
Tamatave Pt., ꜔	18 10	49 27
Fong Is., small, S one	18 26·3	49 23·7
Vatomandri	19 17·8	49 2
Mahanuru, town	19 54·0	48 50·2
Fanantara, town	20 51·2	48 31·2
Rangazava, town	20 58·2	48 30·7
Footak, town	24 4·0	47 30
Manambatoo (South), town	24 17·1	47 23·0
Loodatoo, town	24 36·7	47 15·5
St. Luce, N islet	24 44·7	47 12·2
Pt. Ytapere, extr.	24 59·7	47 5·7
Fort Dauphin, fl. st.	25 1·3	47 0·2
Islands off Madagascar.		
Islands in Mozambique and off Madagascar		
Europa I., [1 l.], ✳, 65f.	22 22·5	40 24·2
Bassas da India, [2 l.]. ⊤, S pt.	21 31	39 41
St. Juan da Nova, [2½m.]. *l*, δ, ~	17 3·5	42 47
Mayotta, NS 7 l., Pamanzi I., lt F.	12 46	45 15
Johanna, NS 8 l, pk., E part	12 15	44 27·1
— Town, w, r, P′	12 11·0	44 22
Numachao Mohillah	12 25	43 42
Comoro, NS 12 l., ⊤, ‡ NW, SE pt. ○	11 54	43 33
— North-east pt. ○	11 19·5	43 39
Geyser sh., SW elbow	12 25	46 25
Borneo shl.	12 14	46 12
Glorioso I. and rfs. [4 l.], *l*, ⚓ ✳, ⊤, Isle du Lise, W pt.	11 30·2	47 22
Assumption I., $\frac{6}{6}$ 2 l., *l*, ✳, hummock on SE pt., 60f.	9 46	46 30·5
Aldabra Is., EW 8 l., ⊞ ? ⚓, r̄, W pt., 70f.	9 22·5	46 12·2
Cosmoledo Is., [3 l.], lag., no entr., r̄, [‡] S; — SW, or Menai I., ☨, ⚓, 40f.	9 41	47 31
Astove, small, *l*, centre	10 6·5	47 45·7
African Coast continued.		
Lindy R., w, r, fort	9 59·5	39 43·7
Mehinga B. Vill.	9 44·4	39 44
Kiswere Hr., ⊞, Rushingi Vill	9 25·6	39 37·5
Pagoda, Pt.	9 1·7	39 33·2
Quiloa, ⊞, fort	8 57·0	39 31·2

(50) Places	Lat.	Lon. E
East Coast of Africa ⊕	South	
Quiloa, Ukyera reef, E extr.	8 53′·5	39°39′
Songa I., $\frac{4}{4}$ 1½m., SE pt.	8 32·5	39 31
Mafia I., $\frac{4}{4}$ 9 l., W. or Kisimani pt.	7 56·5	39 35·7
Pauna Pt. extr.	7 2·0	39 34·2
Latham's I., [2c.], *l*, sd., mid.	6 54·2	39 56
Zanzibar I., $\frac{2}{2}$ 16 l., ⚓, S pt. or Kizimkaz, w, lt.	6 28·5	39 30·0
— English Consulate	6 9·7	39 11·2
— N pt., or Nungwe Pt., lt. Rev. 105f.	5 43	39 18
Mazeewy I., and rfs., [1½m.]	5 30·0	39 6·0
Tungaty, Mt., 15 l., S pk	5 22·3	38 52·0
Pemba I., NS 13 l., *l*, ⚓, S or Saïd pt.	5 29·3	39 39
— North-East pt.	4 54·2	39 51·5
— Port Chak chak ⊞, Mosal I., [1m.]. SW. pt.	5 15·7	39 37·5
Waseen Peaks, 15 l., mid one	4 30	39 20
Mombaza, *l*, ⚓, w, r, P, fort.	4 4·0	39 41·0
Melinda (Leopard rf. 3m. off), Pillar	3 12·8	40 18·2
Ras Gomany, N pt.	3 0·0	40 17·7
Ozy Pt., (Riv. $\frac{4}{4}$ 5m.; rf. 4m.)	2 37·5	40 38·5
Lamo B., ⊞, W pt., or Ras Kattow	2 18·7	40 56·7
— Town	2 15·7	40 56·2
Patta B., ⊞, rk.	2 14·0	41 1·2
Patta, town	2 9·2	41 7·5
Kwyhoo I., Sst. of Juba, or Dundas Is., pk. 155f.	2 0·0	41 18·2
Simmambaya, Setllem.	1 45·5	41 32·0
Mt. Gibbons	1 12·2	41 28
Port Durnford, ⊞, Foot Pt., N. entr.	1 13·2	41 54·2
Tola I., huts	1 0·0	42 3·5
Port Kiama, Doubt rk., mid entr.	0 40·2	42 20·0
Kismayo I., $\frac{4}{4}$ 3m., N pt.	0 36·8	42 22·0
Juba R., bar, P, entr.	0 14·5	42 39·2
	North	
Brava, town	1 6·8	44 3
Marka, town	1 44·1	44 51
Magadoxa, town, P,	2 1·8	45 24·7
Murot hill	2 41·3	46 17·2
Ras Asuad, *l*, ⊥, pt.	4 34·2	48 6·0
Ras Awath	5 32·8	48 40·0
Ras al Khyle	7 43·5	49 45·7
Ras Mabbere, ⊥′ N, $\frac{}{6}$ w, pt.	9 29·0	50 50·2
E extr. of Africa, Ras Hafoon, 500f., ‡ S, w, r, E pt.	10 26·8	51 22·0
Hor Hadeea, (boats)	10 34	51 10
Ras Banna (w $\frac{}{4}$ 11m.)	11 9	51 10
C. Guardafui (NE extr. Afric.)	11 50·0	51 16
Gulf of Aden.		
Abd'l Koory, $\frac{6}{6}$ 7 l., *h*, ẘ, W pt	12 13·5	52 3
Salt's white rks. or Kal Faroon [1m.], 282f., mid.	12 26	52 8
Brothers, 2, $\frac{5}{5}$ 4½l. E, or Durjy	12 7	53 16
Socotra, EW 70m., W extr. pt.	12 33	53 15·7
— NW extr., Ras Bedoo, 300f.	12 39	53 21·7
— Gollonsier, vill., w, r, b.	12 41·5	53 26·7
— Tamareed, r, w, Mosque	12 39·0	53 59
— E pt., Ras R'dresser, *l*.	12 34	54 27·7

MARITIME POSITIONS

(51) Places	Lat. N	Lon. E
Socotra		
Socotra, Wadde Fellingk, w, reservoir	12°28′	54°13′7
— SW pt., Ras Kattaunie, sum. over, 1465f.	12 22·5	53 29·7
Ras Ahileh, *l*	12 0	50 45
Ras Feluk, ⊥, 800f. T	11 57	50 38
Meyet, or Burnt I., *h*, w, S side, ⚓, 430 f.	11 14	47 16
Berbereh Sandy pt., lt. F 49f.	10 25	44 59
Zeyla, r, P	11 21	43 29
Cape Obokh, lt. F 64f.	11 57	43 17
Ras Bir (w′ W 4m.), lt. F.	11 58	43 22
High Brothers, 5, 4m., rks, large one	12 29	42 23
RED SEA, Western Shore.		
Red Sea, W. Coast		
Jebel Searjan, volc., sum.	12 29	43 17
Dumeirah I., [¼m.], *h*, pk.	12 43	43 7·5
Asab, lt F	13 0·5	42 44
Ras Bilul, sum	13 14	42 32·5
Mohabbakah Is., 3, 2m., SW. Flat, 40f.	13 25	42 32·5
Rakhmat I., 282f.	13 40·2	42 12
Jebel Abayil I., 150f.	13 54	41 58
Barn rock, 10f.	13 59·5	41 51·5
Eid town	13 57	41 38
Kurdumiyat I., 180f., [2m.], *h*, volc.	14 7	41 39
Hanfelah B., Daramsas I., 25f. W. reef	14 44·5	40 51·5
Shumna I., lt. F 59f.	15 32	39 59·5
Howakel I., 7 m., sum., 720f.	15 9	40 14·5
Massowah I., [½m.], w, r, b, ⚓′, lt. F 47f.	15 38	39 28
Dahalak bank, SE extr., Mojeidi, [1½m.], *h*	15 31	40 50
— N extr., Harmil I., 5m., *l*, E pt.	16 32	40 12
Dahalak Kebír, 10 l.	15 37	40 0
Difnein I., 30f.	16 36 5	39 18·7
Towers, hill	17 38	38 43
Khor Nowaret, ⊞, r₀. Shatireh I.	18 15 2	38 19 5
Ras Asis	18 26·5	38 7·7
Low Sandy Is., 12 l., E extr., Eddom Sheikh I.	18 37	38 50·5
Trinkitat Harbour	18 41	37 44
Barrmusa Kebir I., [3m.],	19 13 5	38 10
Sawakin, ⊞, w, r	19 7	37 20
Omm el Kurush bk., [1m.], *l*, sand	20 51	37 26
Chimney Hill	20 28 5	37 48
Mahommed Ghoul	20 54	37 9
Ras Raweyyah, rks., 3m., E pt.	21 3	37 19
Reef, 3m., S pt.	22 0	37 0
South Peak, 6900f.	21 53	36 29
Merza Halaib, ⊞, w, b, P, entr.	22 15	36 38
Seal Is., 3, *l*, ✶ ✶, E one	22 47	36 12
St. John's, or Seberget I., small, 700f., T	23 36 3	36 9
Macour, or Emerald I., [1m.], 100f., T, ⚓₀	23 50	36 47

(52) Places	Lat. N	Lon. E
Gulf of Suez		
Ras Benass, T E, δ SE, pt., *l*	23°56′	35 47′
Jebel Wady Lehuma, vis., 100m.	24 12	35 0
Wady Jumaul I., 2½m., *l*, mid	24 39	35 8
Dædalus shl. (*Abd'l Kheesan*), T, lt. F 61f.	24 56	35 52
Kosair, town	26 6	34 16 7
The Brothers, 2 Is., 1½m., T, N Islet, lt. F 71f.	25 18 8	34 50 7
Jaftatin I., Sereca pk.	27 12	33 58 7
Shadwan I., 7m., 700f., T, SE pt., lt. Fl. 120f.	27 27	34 2·5
Jubal I., [2½m.], T E, sum.	27 38·7	33 48
Ashrafi Is., lt. F 125f.	27 47·3	33 42·5
Ras Gharib, lt. F 165f.	28 20·9	33 6·5
Ras Zafarana, lt. F 83f.	29 6·5	32 39·7
Mt. Agrib (Gharib), 5740f.	28 6 7	32 54
Suez, Port Ibrahim, S mole hd.	29 56·2	32 33·5
Toor, harb., ⊞, w′′′	28 13 7	33 37
Mount Sinai, 7450f.	28 32	33 58·5
Ras Mohammed, ⊥, 90f., peninsula	27 45·2	34 13 5
Akabah, fort, w̄	29 28	35 1
Tirahn Is., 3m., pk., 700f.	27 55·2	34 34
Eastern Shore.		
Red Sea, E. Coast		
Sillah Is., 6m., *l*, crl., S pt.	27 37	35 16
Moilah, w, r, ⚓	27 40	35 28
— High pk., 9000f.	27 37	35 45
Jebel Antar, 2500 or 3000f.	26 34	36 28
Riackah I., 2m., *l*	26 10	36 21
Mushabeah I., 5m., *l*, T w, W extr.	25 38	36 27
Shab Shaybah, or Palinurus rfs., [4m.], T, ⚓₀, δ; mid.	24 6	37 7
C. Bareedy, mid. pt, T	24 16	37 33
Sherm Yembo, ⊞	24 9	37 54
Yembo, the port of Medina, w′ r, entr.	24 4 5	38 1
Jebel Soubah, 4500f.	23 18	39 3
Shab Subbah, or 7 shls., 3 l., δ, W lim.	23 40	37 58
Thetis, rf., [½m.], T, δ	23 38	38 1
Sherm Rhabuc, ⊞, r, w, P	22 43	39 4
Abu Madafi	22 2	38 42
Jiddah, ⊞, δ WSW 7m., high mosque, E-d. of town	21 28·3	39 13 0
Kadd Homeis, 5f. [2½m.], β, W pt.	20 15	39 26
Lith	20 0	40 12
Kunfidad	19 7 7	41 3 2
Shab Mubarak, rk, [1m.]	19 0	40 9
Khor Nohud	18 15 8	41 27·5
Shab el Jumah, [1m.]	17 36	40 50·5
Seil Makawar, [1m.], (δ, NW 3 l.)	16 58	41 20
Gizan Fort	16 53	42 29
Jebel Teer, volc., [1½m.], 800f., ⚓₀	15 32 5	41 50
Kotumah I., 3m.	15 41	42 16
Loheyyah Fort	15 42	42 39
Kamaran I., NS 3 l., w, b, S sum.	15 17	42 34
Zebayir Is., 5 l., N extr., Quoin rk., 100f.	15 12	42 3

MARITIME POSITIONS

(53) Places	Lat. N	Lon. E
Red Sea		
Zebayir I., large one, [3m.], S. sum. 734f.	15° 2′	42°10′2
Hodeidah	14 47	42 56
Ras Zebeed, w‴ 1m. N.	14 7	43 4·5
Avocet rock, δ	14 22	42 41·7
Jebel Zukur I., 2047f., $\frac{2}{12}$ 10m., *h*, High islet, 216f.	14 5·2	42 45·2
— Tongue I., 166f.	13 53·4	42 42·2
Harnish Is., 1335f., NS 6 l., Haycock I.	13 47·2	42 47
— SW rocks, 22f.	13 38·2	42 35·5
Mocha, Pier end	13 19	43 14·0
Bab el Mandeb, pk.	12 41	43 27
Perim I., [4½m.], ⊞, lt. R 249f. on summit	12 39	43 26
ARABIA.		
Arabia, S. Coast		
Ras Arab, S pt. of Arabia, *l*, δ	12 35	43 56
Mt. St. Antony, 2772f.	12 43	44 10
Aden, Ras Márbut	12 47·2	44 58·5
C. Aden, summit, 1776f.	12 46	45 0·7
Ras Marshigh, lt. F 244f.	12 45	45 3
Sugrá, w′, r, Castle	13 21·5	45 40
Howtha, w′, r, r̄	13 25	46 45
A barn-like pk., 5284f.	14 4	47 32
Ras Khelb, *l*, sandy, no point	14 2	48 40
Makalleh	14 31	49 7
Jebel Dhebah, a table land	14 41	49 26
Shahah, Sultan's resid., r, w,	14 43·7	49 35
C. Bogashu	14 49	50 4
Palinurus shl. 2½fm. $\frac{2}{12}$ 2m., T *T* S pt.	14 53	50 39
C. Fartak, 26 l., ⊥	15 39	52 16
Ihurbat Ali	16 38	53 3
Ras el Ahmar	16 55	53 52
C. Merbat, *l*, rky., r̄, w,	16 58	54 42
Jebel Kinkeri, 1300f.	17 3	55 2
Ras Nus, 20 l., S pt., *l*	17 14	55 18
Kuria Muria Is., EW 45m., W one, Haski, $\frac{2}{2}$ 1½m., pk	17 27·2	55 35·7
— Soda, $\frac{6}{6}$ 3m., pk., 1310f., w	17 29·6	55 51·2
— Helánea, EW 7m., NE bluff, 1645f., w,	17 32·7	56 2·2
— Kiblíyah, EW 2m., pk., 550f., w₀, r̄k. W 3m.	17 29·2	56 19
Ras Sherbedát, ⊥, w 4m., W	17 53	56 20
C. Isolette, vis. 16 l., pt.	18 58·5	57 46·0
Mazeira I., $\frac{2}{2}$ 13 l., 600f., S pt.	20 7·6	58 33
— N pt., or Ras Jeï	20 43·5	58 52
Ras Jibsh	21 27·5	59 21·5
Ras el Khubbeh	22 14·4	59 49
Ras al Hed, Sandy Pt., *l*	22 33	59 48
PERSIAN GULF.		
Gulf of Oman		
Ras Abu Daud	23 19·2	58 55·5
Maskat, r, w, r̄, Fisher's rk. ⊕	23 37·7	58 36·0
— Saddlehill, 1340f.	23 35·1	58 35
Jeziret Jun, 107f.	22 50·5	57 58·5
Clive Shoal, 3f.	22 51	57 57·2
Jebel Rostag, a bluff of the Jebel Akhthar	23 14·2	56 16
Bukeh	23 42·7	57 54·2
Suwik, fort and town	23 51·5	57 26
Sohar, town and fort	24 21·5	56 46

(54) Places	Lat. N	Lon. E
Persian Gulf, S. Coast		
Schenas, town	24° 45′	56° 29′
Dibbah, town	25 38	56 17
Shám Peak, 6750f.	25 58·7	56 14·5
C. Mussendom Peak, 875f.	26 21·9	56 32
Great Quoin, 540f.	26 30	56 31
Ras Sheikh Masud	26 15·4	56 13·2
Shám, fort, r, w′, P′	26 1·4	56 5·5
Ras el Kheymeh, r	25 48	55 57
Shargah, w, ⚓,	25 22	55 24
Abúthabí fort	24 29	54 21·7
Sír Bení Yás, N pt.	24 21·5	52 38
Rug Zakkum shl. [3]	24 48·5	53 46
Ras Luffan	25 54	51 33
Sír Abú Neyr, NS 2½m., N pt. 240f.	25 15	54 13·5
Zirkuh I., 540f., S pt.	24 52	53 5·2
Girneyn I., 190f.	24 56	52 52
Dás I., [1½m.], S pt., 145f.	25 9	52 53
Arzeneh, 200f.	24 46	52 34
Dalmeh, 244f.	24 33	52 19
Deyni, 9f.	24 57	52 24
Shiráao I., 40f.	25 2	52 14
Halul, 180f.	25 40	52 26
Ras Rekken	26 11	51 13
Shah Allum shl. [2½]	26 25·5	52 31
Bahrain I., Manamah, town, r, ẇ	26 14	50 35
Maharag I., N pt.	26 18	50 38
Rennie shl. [2¾]	27 3·5	50 42
Al Krán, 5f.	27 43	49 50
Herguz, 3f.	27 56	49 42
Araby, 3f., sandy	27 47	50 11
Farsé, 10f., sandy	27 59	50 10
Ras al Ghar	27 33	49 16
Ras Mushâb, *h*	28 11	48 39
Garú I.	28 49	48 47
Kúbbr I.	29 4	48 31
Ras al Arth	29 20	48 8
Kuweit, N end town, ⊞	29 23	48 0
Feylecheh I., $\frac{4}{4}$ 7m.	29 23	48 21
Basrah Custom House	30 32	47 51·5
Ras Tanub, *l*	30 8	49 ·6
Ras at Tamb	29 58	50 10
Persian Gulf, N. Coast		
Khargú I., NS 4m., *l*, w, N pt.	29 20	50 22
Kharg I., $\frac{2}{12}$ 5m., w′, fort. NE ⊕	29 15·4	50 20·7
Abu-Shahr, ⊞, w, r. Residency ⊕	20 59·1	50 50
Asses' Ears, 5m. inland, 2500f.	28 29	51 12
Hummocks of Dreng, S one, 3270f.	28 4	51 37
Ras Mutaf, S pt.	27 41	51 45
Konguin	27 49·5	52 4
Barn Hill, 4660f.	27 48	52 14
Ras Nabend, *l*	27 23	52 35
Sheykh Sháyb, 120f., I., $\frac{6}{6}$ 14m., w, P,, E pt.	26 48	53 24
Hinderabi I., EW 4m., *l*, 100f.	26 41	53 40
Samberrun Shl., [6]	26 33	53 44
Gays, 120f., $\frac{6}{6}$ 8m., *l*, ⚓, *T*, r, w̄, P,, E pt.	26 31	54 3·5
Frúr I., 465f., NS 4m., N pt.	26 19	54 30·5
Ras Bostaneh, *l*, pt.	26 30	54 37
Frúr Shl. [½m.], 2	26 20	54 32·5
Nábyu Frúr I., [1m.], 120f.	26 7	54 20·5
Seri I., 50f. [3m.], S pt.	25 53	54 33
Bumusa I. [3m.], 360f., peak	25 53	55 3

MARITIME POSITIONS

	(55) Places	Lat. N	Lon. E
Persian Gulf, N. Coast	Jezt. Nabu Tumb [1m.]	26° 14'7	55° 9'
	Jezt. Tumb [3m.], 165f., w...	26 15·7	55 18·7
	Basidúh Chapel	26 39·2	55 16·2
	Henjar I., 5m., S pt.........	26 36	55 52
	Kesm, fort	26 57·5	56 17
	Larek I., 5½m., δ₀ ½m., N pt. l	26 53·1	56 21·7
	Hormuz I., EW 4m., fort, N pt.	27 5·8	56 27·5
	Bander Abbas, Sheikh's hous ⊞, ☨	27 10·5	56 17
	Kúhí Mubárek, rk	25 42·2	57 28
Makran Coast	C. Jashak, l, sandy pt., Tomb	25 38·3	57 45·7
	Ras Tagin, l	25 33	58 5·5
	Ras Maidani l, (shl 3m.)	25 23·7	59 6·5
	Ras Gurdim, ⊥, (rk, SE 3m.)	25 19	60 7·2
	Ras Mutakaddim	25 16·5	60 27·7
	Chahbar, ‡', r̊, w', Telegraph	25 16·7	60 37·2
	Ras Fasta	25 3	61 25·2
	Gwatar, vill.	25 8·9	61 30·2
	Ras Jiyuni	25 0·5	61 42·2
	Guadar Telegraph	25 7·3	62 19·2
	Ras Shahid	25 12	62 58·7
	Pasni Telegraph	25 15·9	63 28
	Astaluh I., EW 3m., (rk., 2m. S)	25 6·2	63 49
	Ormarah, Telegraph	25 11·9	64 36·5
	Ras Malan	25 18	65 12·2
	Sanmiyani, r̊, ẇ, Jam's ho. ...	25 25·3	66 35
	Ras Muwari, or C. Monze, shl., 3m.	24 50	66 39·5
	INDIAN OCEAN. Islands.		
Laccadive Is.	Laccadivas, l, ☨, ‡₀		
	Bassas de Pedro bk., 22l., T, N pt., ...	13 37	72 32
	— rf., NS 6m., T, S dry sand (Cherbaniani) ...	12 16	71 52
	Byramgore, rf., NS 13m., S part	11 48	71 50
	Betra-par, rf., NS 7m., Id., [1m.], N extr., l	11 35	72 11
	Peremul-par, rf., 7m., T, Id. NE	11 9	72 0
	Ancutta, [3½m.], P, ☨, mid....	10 51	72 10
	Tingaro	10 55	72 18
	Pittie, [2c.], sand, ...	10 45	72 32
	Ameni, [1½m.]	11 6	72 41
	Cardamum, and rfs., NS 6m ..	11 13	72 44
	Chittac, [2m.]	11 40	72 42
	Kittan, [3m.], S pt.	11 29	72 58
	E extr., Elicalpeni bk., NS 5m., mid.	11 13	73 56
	Underoo, EW 3¼m., rks., N-d. l, ☨, w, E end	10 47	73 42
	Kalpeni, 2 Is., 7m., ☨, S pt.	10 3	73 35
	Cabrutee, [2½m.], rf. W-d, T, ☨, w	10 31	72 36
	Seuheli Par, Id., N, [2c.]	10 5	72 15
	— S extr. of rf., T	9 56	72 9
	Minikoy, 6½m., ☨, P', lt. R 150f	8 15	73 1

	(56) Places	Lat.	Lon. E
Maldive Is.	**Maldives.**	North	
	Maldiva Is., 19 *Atolls*, or groups, l, T, |||, ☨. P'		
	N extr., Heawandoo Pholo Atoll, 4 l., ⊞, w', N pt., Turacoon I.	7° 6'	72 53'
	Heawandoo I., [1m.], ☨, on SW side, w, ...	6 57·5	72 54
	Tilla, and Milla, dou Atolls, E extr.	5 51	73 27
	— N Id., Keelah, [2m.], ☨ ...	6 50	73 12
	— S extr.	5 39	73 15
	Malcolm Atoll, 5 l., rf., Mah-koondoo I., [1m.], w' at NE extr.	6 24·5	72 40
	Powell's Is., 2, 2m., N one	5 59	72 54
	Paddipholo Atoll, 7 l., E pt.	5 25	73 38
	Cardiva I., 1⅓m., ☨, w' ...	4 58	73 26
	Horsburgh Atoll, 10m., entr. S, ‡', E extr. Id., w	4 54	72 58
	A lagoon rf., EW 6m., N pt...	4 46·5	73 23
	Malé Atoll, NS 33m., E extr.	4 27	73 42
	— King's I., fl st., N side......	4 10	73 29
	South Malé Atoll, 7 l., S extr.	3 48	73 25
	To-doo I., [1m.], w'	4 26	72 58
	Ari Atoll, NS 16 l., ‡' N, I. at S pt. w'	3 30	72 50
	Pha-lee-doo Atoll, EW 10 l., E extr.	3 27	73 44
	Moloque Atoll, 8 l., S extr.	2 45·5	73 23
	— Do Id., on N side entr. ⊞, w, b, r̊	2 57	73 33
	Nillandoo Atolls, 2, ||, NS 13 l., Id. at S entr., ☨, w', on W side entr.	2 40	72 54
	Collomandoo Atoll, EW 10 l., Karn-doo-doo I., w', ⊞...	2 20	72 55
	Adou Matte Atoll, 9 l., N and E pt. Id.	2 7	73 35
	— S extr., Id., (entr. ⊞, 3m., δ₀)	1 46·5	73 22
	Suadiva Atoll, NS 15 l., W side, entr. to ⊞, ...	0 28	72 56
		South	
	Phoowa Moloku I., w', N pt.	0 16·5	73 23
	S extr., Addoo Atoll, EW 3 l., w, b, r̊, Gung I., ⊞, E pt.	0 41·5	73 6
	Almirante & Seychelles.		
	W extr., I. Boudeuse, small, ☨ ⊖	6 11	52 56
	Marie Louise I., small, ☨, (rf. off, 4)	6 10·4	53 9·2
	S extr., I. De Neuf, small, ...	6 14·5	53 14
	I. Etoile, [1½m.], l, ...	5 48	53 9
	Poivre Is., two, [1m.], rfs., NE pt.	5 45·2	53 19·5
	Isle de Roches, (bks. 4 l.), North beach	5 41	53 41·2
	St. Joseph Is., E pt. ....○	5 27	53 37
	D'Arros I., NE pt.	5 24·4	53 18·5

MARITIME POSITIONS

Group	(57) Places	Lat. S	Lon. E
Almirante Is.	Eagle, or Remire I., [½m.], *l*, ✻, rfs. 2m., w₀, NE pt.	5° 6'·4	53°19'
	African Is., small, *l*, ‡' W, w₀, North I.	4 52·5	53 23·7
	I. Platte, [½m.], rfs. 3m.	5 52	55 22
	La Perle rt., Centre	6 1	55 17·5
Seychelle Archipelago	Mahé I., 2/12 13 l., ☨, Port Victoria, Hodoul jetty	4 37·2	55 27·5
	— lt. F 37f. on S reef	4 37	55 31
	Silhouette I., [3m.], *h*, ✻, N pt.	4 27·0	55 16·7
	Recif I., [1½ m.], 150f., ~, mid	4 34·8	55 50
	E extr., Frigate I., [1½m.], 550f., P, rt. SW, mid	4 35·2	56 1·2
	Pra-lin I., 12 l., ‡ N, W pt.	4 17·4	55 44·2
	Curieuse I., EW 2m., w, ☨, mid.	4 16	55 47·7
	Denis I., NS 3m., *l*, ✻, lt. F 60f.	3 48·2	55 40
	N extr., Bird I., [2m.], *l*, ✻, ~, w̄, mid.	3 42·7	55 12·5
	French Shoal, [5 or 6m.], 3, mid. ○	3 58	54 42
	Roquepiz, *l*, sandy, rfs.	6 24	60 4
	Alphonse, *l*, ✻, SE pt.	7 0·5	52 45·2
	Coetivy I., *l*, sandy, 4/4 8m., ☨, ‡ NW, w', r̄, N pt.	7 6	56 17
	Agaleg̃as, I. and reefs, 4/4 5 l., ✻, NW pt.	10 21·5	56 32
	Sava de Malha bk .5 fms. patch	9 12	60 21
	John de Nova, or Farquhar Is., 4/4 8 l., w̄, ✻, Grande Porte	10 7	51 10·2
	McLeod, or Marq. of Huntly bk., [2 l.], 10	9 55	50 15
	St. Pierre, [1¼m.], *l*, ✻, NW pt.	9 19	50 43·5
	Providence I., [2m.], w, r̄, *l*, Village	9 14	51 2·5
	Umzinto blk. coral 11 fms.	9 39·5	51 18
	Tromelin, [1m.], *l*, or Sable I., δ, N pt.	15 51·6	54 27·7
	Cargados Carajos reefs, 2/2 9 l., *l*, T E, r̄, S extr., Coco I., ☨₀	16 48·9	59 31·5
	— Baleine shl., r̄f, [¼m.]	16 40·7	59 32·2
	— Establishment	16 26·5	59 37·5
	Albatross I., [⅓m.], ₀	16 15·0	59 36·5
	Chagos Archipelago.		
Chagos Group	Speakers' bk., 2/2 8 l., T, 6, NE pt.	4 45	72 24
	Blenheim r̄f., 2/2 6m., T, N pt.	5 9	72 25
	Salomon Is., 4/4 5½m., ⚓, N Id., E of entr., or I. de Passe	5 18	72 12·7
	— SW, or Boddam I.	5 21·5	72 9·7
	Peros Banhos, 27 Is., 4/4 6 l., *l*, ⚓, I. de Passe, E side, entr., mid.	5 14·0	71 46·0
	— Diamond I., [1½m.], estab.	5 15	71 42·7
	S extr., Foquet I., *l*, ✻	5 27	71 46
	Benares shl., 6/6 1½m., T, mid. 6	5 15	71 37
	Victory bk., 6/6 4m., E pt., 3	5 33	72 13
	Great Chagos bk., 6/6 32 l., T, E extr., 8	6 5	72 43
	Nelson's I., [1m.], *l*, ✻	5 40	72 16

Group	(58) Places	Lat. S	Lon. E
	Great Chagos bk., N extr., 5	5°39'	72° 1'
	— NW extr., Eagle Is., 4/4 5m., *l*, ☨, N pt.	6 10·5	71 18
	— W entr., Danger I., [1½m.]	6 23	71 13
	Egmont, or Six Is., 6/6 6m., T, SE Id., ☨	6 40	71 22
	Pitt's bk., 4/4 10 l., T, N pt., 10	6 49	71 10
	— West extr., 10	7 2	71 4
	A Reef, NS 2 l.	7 11	72 36
	Ganges' bk., 4/4 4m., W extr., 8	7 22	71 2
	Diego Garcia NS 13m., *l*, ⚓, ☨, r̄, w̄, Mid I., E entr.	7 13·5	72 23·7
	— South pt.	7 26·0	72 23·2
	Islands in Southern Indian Ocean.		
Islands in Indian Ocean	MAURITIUS, PORT LOUIS, Martello Twr., Ft. George	20 8·6	57 29·0
	— Round I., [1m.], 1049f.	19 50·5	57 47·5
	— Peter Botte, 2600f.	20 11·3	57 33·5
	— Grand Port, Fouquet Id., lt. F 108f.	20 23·5	57 46·7
	Bourbon I., 4/4 14 l. St. Denis, 2 lts., F, vert., 85f.	20 51·5	55 27·5
	— Pt. of Bel Air, lt., F 148f.	20 53·2	55 36·5
	— South extreme	21 22·5	55 39
	Rodrigue, EW 15m., ▼'s. 14 l., rfs., 5 l. to SW-d., Point Venus	19 40·4	63 26·2
	Keeling Is., ☨, *l*, N Id., [1¼m.]	11 50	96 51
	— S grp., Borneo Coral Is., ⚓, NS 8m., S pt.	12 12·6	96 54
	— Direction I., [¾m.], SW pt	12 5·4	96 33·0
	Christmas I., EW 3 l., vis. 12 l., ☨, ⚓ NW, Flying-fish cove	10 25·3	105 43
	Enderby's land, pt. uncertain	67 30	44 0
	Bouvet's I. ○	54 20	5 24
	Thompson's I. ○	53 56	5 30
	Prince Edward's I., 2 [5 l.], and [3 l.], *h*, ✻₀, West I.	46 34	37 56
	Marion I., East cape	46 52	37 53·5
	Crozet's Is., Hog I., *h*, ⊥, ‡₀, (a rf. SE 9 m.)	46 10	50 28
	Kerguelen's land, 4/4 32 l., Christmas Harb., ⚓, b S side, N pt., or C. François	48 40	69 4
	— Bligh's Cap, *h*, ✻₀, 230f.	48 27	68 48·5
	— C. St. Louis ○	49 15·5	68 38
	— C. Challenger	49 43·5	70 5
	— E extr., C. Sandwich	49 11	70 33·5
	Heard or McDonald Is., 4/4 50m. Meyer rk., NW extr.	53 1·5	72 31
	St. Paul's, 4/4 3m., 860f., ‡ E, r, Ninepin rk. on E side, (w' ¼m.)	38 42·7	77 34·7
	Amsterdam [4m.], ẇ, sum. 2760f.	37 50·7	77 31·5

MARITIME POSITIONS

	(59) Places	Lat. N	Lon. E
	HINDUSTAN WEST COAST.		
	Karâchi, ⚓, fort, lt Rev. 154f.	24°47′3	66°58′1
	Indus R., months always changing, Kukewári mo.	23 57	67 25
	Manivee, town	22 50	69 18·2
	Bate, fort	22 28·5	69 9
	Pt. Jigat, or Dwarka, temple	22 14	68 57
	Conical Hill	20 57	71 18
	Diu Hd., pt., lt. Fl 106f.	20 40 7	70 51
	— Island, Watch Tower	20 42 7	70 59
Hindustan, W. Coast ⊕	Jarabad, ⚓, lt. F 75f.	20 51 6	71 22·0
	Shalbet I., [¾m.], rfs. 1m., mid	20 54	71 31
	Goapnauth Pt., lt. F 68f.	21 12·3	72 6·5
	Perim I., rfs. NS 5m, lt. F 129f.	21 35 3	72 20
	Gogo, town, w, ŧ, lt. F 55f.	21 40·0	72 16 5
	Cambay, fl st.	22 17·0	72 35·5
	Surat Castle	21 12·0	72 47
	Vaux's tomb, Tapti, lt. F 130f.	21 5·7	72 37·5
	Damaon, r, lt. F	20 24	72 49
	St. John's Highland	20 2	72 43
	Versavah fort	19 7	72 46
	Basseau R.	19 18	72 49
	Terrapore Pt.	19 52	72 40
	Bombay, ⚓, [b], Observʸ, ♦	18 53 8	72 49 0
	— Lighthouse, lt. Fl. 136f.	18 53 7	72 48·0
	— Kunderi, lt. F 148f.	18 42	72 48
	Coulaba I.	18 37	72 51
	Chaoul, ⚓, ³	18 34	72 54
	Rajpuri Harb. Pt., lt. F 179f.	18 17	72 56
	Bancoot R., 16f. bar	17 57	73 1
	Severndrong I., *l*	17 47	73 5
	Angenweel Harb., ⚓, fort, S entr	17 33·4	73 14
	Zyghur Pt., ⚓, ⚓	17 16	73 10
	Ratnagiri fort, lt. F 308f.	16 59	73 16
	Geriah Pt., *h*, fl. st., ⚓	16 31	73 22
	Angria bk., NS 7 l., ⊤, in S pt.	16 18	71 43
	Vingorla rks., [5m.], 20f., ⊤, beac., lt. F 100f.	15 53	73 27
	Agoada Pt., w‴, (Goa), ⚓, r, lt. Rev. 280f.	15 29·5	73 46
	Marmagoa, r, fl. st.	15 24½	73 46·7
	St. George Is., [2m.], *h*, outer	15 21	73 45
	C. Ramas, *h*, ⊥, W extr.	15 4 2	73 54 7
	Oyster rks, [½m.], lt. F 210f.	14 49	74 2
	Carwar Hd.	14 47	74 10
Malabar Coast ⊕	Anjediva I., [¼m.]	14 45	74 5
	Merjee R., w′, b, bar 2, N bluff	14 30	74 21
	Fortified I., ẇ, [1m.]	14 18·5	74 23·2
	Pigeon I., vis. 8 l., ⊤	14 1	74 18
	Barsalore Pk., 4452f.	13 50	74 51
	St. Mary's rks., 5m. out, large one	13 20	74 40
	Premiera, or Molky rks.	13 11	74 38
	Mangalore hill lt. F 240f.	12 52	74 50
	Barn hill	12 40	75 1
	Mt. Dilly, 8 or 9 l.	12 2	75 11
	Cananore, pt., ⊤, w′, lt. F 64f.	11 51·2	75 21 7
	Tellicherry, r, w′, lt. F 88f.	11 44 9	75 28 2
	Sacrifice rk., 20f., ⊤	11 30	75 30
	Calicut, lt. F 103f.	11 15 2	75 45 7
	Chitwa, Ch.	10 33	76 1

	(60) Places	Lat. N	Lon. E
	Cranganore R., fort, bar 5f.	10°12′	76°12′
	Cochin, w, r, bar 11f., (lt. F 100f.)	9 58	76 14
	Quiloan, fl. st.	8 53 5	76 33 2
	Anjenga, ⊥, ẇ, fl. st.	8 39 0	76 45 0
	Trevandrum Pagoda	8 29·0	76 56
	C. Comorin, pt.	8 4 0	77 32·5
	— Peak	8 23·2	77 30 5
	Minikoi I., lt. Rev. 150f.	8 15	73 1
	Manaar Pt., ⊤ ⊤	8 22	78 3
	Trichindore pagoda	8 30	78 7
	Puonecoil, w, r, b	8 40	78 6
	Paumben Pt., fort	9 17 0	79 14
	CEYLON.		
	Calpentyn, fort	8 15	79 45
	Negombo	7 12	79 48
	Colombo, r, w, lt. Fl 135f.	6 56 3	79 50 5
	Kalitura	6 35	79 57·5
	Pt. de Galle, [b], ⚓, r, w, fl. st., lt. F 100f.	6 1 8	80 12·5
	Adam's peak, 7000f.	6 52	80 29
	Matura, b. w, fort	5 57	80 33
	Dondra Hd., lt 150f., *l*, ☨	5 55	80 35·5
	Great Bassas, rks., [1m.] ⊤, δ, lt. Rev. 110f.	6 11	81 29
	Elephant rock, inland	6 21	81 28
Ceylon	Little Bassas, rks., lt. Fl. 110f.	6 24·5	81 44
	Komarie	7 2	81 52
	Batticaloa, (bar 6f.), b, w, lt. F 47f.	7 45·5	81 41·2
	Vendeloos B., N or Elephant Pt.	8 0	81 33
	Chelitivo I., 30f.	8 7	81 28
	Foul Pt., lt. F, Fl 104f.	8 32	81 19
	Trincomalee, ⚓, lt. F 103f., Fort Frederick	8 35 5	81 15
	Pigeon I., [½m.], rk., ✶, 99f	8 43 7	81 12 5
	Muletivu House, (shl. 4m.)	9 16	80 49
	Mark House	9 32 5	80 30
	Pedro Pt., ☨, (shl. 5m.)	9 51	80 14·5
	BAY OF BENGAL.		
	Pt. Calimere, *l*, ☨	10 18	79 52
	Negapatam, w, r, bar, lt. F 80f	10 45·0	79 50·5
	Five white pagodas	10 49	79 50
	Tranquebar	11 1 5	79 50 5
	Coleroon Shl.	11 27	79 47
	Porto Novo, w,,	11 30	79 43
	Cuddalore, town and riv., w, r	11 43·5	79 45·7
	Pondicherry, lt. F 89f	11 55·7	79 50
	Alemparva	12 15	80 0
	Mahábalipur pagodas, lt. Fl 116f.	12 37	80 11
	Covelang	12 48	80 15
	Madras, [b], Observatory, ♦	13 4·1	80 14 7
	Ft. St. George, lt. Fl. 128f.	13 4 7	80 17
	Pulicat, lt. F 68f.	13 25·2	80 19 0
Coromandel Coast	Armeghon, lt. Rev. 107f.	13 53	80 12
	Mootapilly shl., [1m.], 3, ⊤, 8m out.	15 25	80 18
	Pt. Divi, lt F 48f.	15 59	81 9
	Masulipatam, lt. F 69f.	16 9 1	81 8·5
	Narsapour, pt., *l*, ✶	16 20	81 42
	Pt. Gordewar, lt. F 83f.	16 49	82 19
	Coringa, town	16 49	82 12

MARITIME POSITIONS

Region	(61) Places	Lat. N	Lon. E
	Vizagapatam, fl. st.	17°41′5	83° 17′
	Santapilly, lt. F 173f.	18 5	83 38
	Chicacole	18 17·0	83 53 2
	Gopalpur, lt. F 85f.	19 13	84 52
	Ganjam, fl. st.	19 22·5	85 3
	Jugurnaut pagodas, large	19 50	85 56
	Black Pagoda	19 52	86 8
	False Pt., *l*, ⚓, lt. occ. 129f.	20 19·4	86 44
	Mypurra I., [¼m.], S pt.	20 41·3	87 7·0
	Pt. Palmiras, *l*, ⚓, (sh. 2 or 3 l. off)	20 41	87 9
Bengal	Balasor R., ⚓₀, Chandipur, lt. F 106f.	21 26·0	87 2
	Kedgeree, lt. F 62f.	21 50·3	87 55 7
	Saugor I., Middleton Pt., lt. F, Fl. 74f.	21 39	88 2
	Calcutta, [h], Fort William	22 33·5	88 19·7
	Diamond Harb., Semaphore	22 11·2	88 10
	Luckipoor	22 55	90 55
	Chittagong, town, jetty	22 19·5	91 49·5
	— River, bar ?, fl. st. at mouth	22 14·1	91 50
	Kutabdia I., 2/12 4 l., *l*, ⚓, lt. F on W side 126f.	21 52·6	91 50
	Shoal Patch, [1m.] ⚓	21 48	91 43
	Elephant Pt., vis. 5 l., rks. off	21 10	92 3
	Table Land, 8300f.?	21 9	92 23
	St. Martin reef, [½m.]	20 38	92 12
	— I., NS 5m., S pt. rks.	20 34	92 20·7
	Oyster Id., δ, rfs., lt. F 75f.	20 12	92 33
	Mosque Pt., or Fakeer's Pt.	20 6·7	92 53 7
Aracan	Akyab harb., ⊞, fl. st.	20 8·4	92 54·0
	Great Savage, lt. F, Fl. 58f.	20 5 2	92 53 7
	Borongo I., 2/12 6 l., hum. S pt.	19 49	93 2
	Kenian kown toung pk., 12 l.	19 48	93 28
	Terribles, NS 6m., W lim.	19 22	93 16
	Kyook Phoo, ⊞, fl. st.	19 26 4	93 32·5
	Beacon I., [½m.]	18 54·5	93 26
	Cheduba I., 2/12 6 l, W pt. volc.	18 52	93 28
	— Town, r, w	18 51	93 42 5
	— South pk., 1700f.	18 41	93 41
	Tree I., [1m.], 250f. ŵ, mid.	18 26·5	93 55
	Sandoway, town	18 26	94 18
	Foul I., 4/4 2m., sum.	18 3	94 6
	Vestal shl., ⚓, [½m.]	18 2	94 14
	Rocky Pt.	17 36·5	94 34
	Gwa, Mosque	17 33 5	94 35·5
	St. John's, or Ch. rks., [½m.]	17 27 0	94 20
Pegu	Calventura rks., 4/4 2 l., NW grp.	16 55	94 14
	Milestone rk.	16 40	94 18
	Coronge I., 2/12 2m., S pt.	16 31	94 14·5
	Shoal, awash, [½m.]	16 29	94 12
	Round Cape	16 16	94 12 5
	C. Negrais	16 1·5	94 10 5
	Diamond I., [1m.], *l*. ⚓, mo. of Pegu R., (rks. off)	15 51·5	94 15·5
	Poriam Pt., ⊥, ⚓	15 49·5	94 23·5
	Aguada rf., 2/12 2m., lt. R.	15 42	94 11
	Elephant Pt., ⚓, pagoda	16 28 7	96 19 2
Gulf of Martaban	Rangoon R., bar ?, City, Dagon Pagoda	16 47 8	96 8·5
	— Eastern Grove, lt. F 93f.	16 30	96 23
	Riv. Settang, E pt. entr., *l*, ⚓	16 28	97 20
	Martaban	16 32	97 35
	Maulmain, pagoda	16 30	97 37
	Quickme, pagoda, (rf. 1½m.)	16 3 1	97 32
	Amherst, pagoda	16 4·7	97 33

Region	(62) Places	Lat. N	Lon. E
	Double I., [½m.], lt. F 164f.	15°52′5	97°34′5
	Callagouk I., NS 6m., w NE, N sum	15 34 5	97 38
	Padoga Pt., Bluff Pt.	15 12	97 47
	Moscos Is., N grp., N Id.	14 27	97 45
	— South grp., S extr.	13 47	97 53
	The Cone, vis. 16 l	14 1	98 24
	Reef I., Tavoy N., lt F 309f.	13 36	98 13
	Cap I., [½m.]	13 32	98 6
	Tavoy Pt., pagoda, ⊥, ⚓, w, b.	13 31·3	98 14·2
	Tavoy town	14 3	98 11
	Tavoy I., 2/12 6 l., pk. (w, S part), Port Owen, ⊞, E-d, w, b, Clyde Pt.	13 5	98 20
	Mergui, SE corner of Court Ho	12 26 2	98 36
	Kabosa, I., 1300f., 4/4 3½m., sum	12 47·6	97 51·5
	W. Canister, [2c.], *h*, ⊥	12 42·0	97 43
	Tenasserim I., NS 3½m., sum.	12 34	97 50·7
	Sir Ch. Metcalfe I., 4/4 3m., sum	12 17	97 47
Mergui Archipelago	GreatWestern Torres, [5m.], W sum., 1413f.	11 47·5	97 27·5
	Black rk., vis. 8m.	11 23	97 39
	Forrest Straits, High I., 1392f.	11 1·5	98 18 5
	Twins, NS 10m., S one, [1m.]	10 28	97 41
	Horsburgh I., [¾m.], vis. 7 l.	10 12	97 52·5
	St. Matthew's I., sum. vis. 18 l.	9 58·0	98 12
	— Hastings Harb., ⊞, ww₀, harb. pk.	10 5·1	98 11·5
	Pt. Victoria, W pt. of Pak Chan R.	9 58·5	97 33
	Westero rocky I., & rks. [½m.]	9 51·5	97 52
	Chance I., 2/12 5m., peak, vis. 12 l.	9 24	97 51
	Middle I., [1½m.], vis. 8 or 9 l.	9 4	97 48
	Sayer Is., NS 4 l., T, pk., 334f.	8 41	97 40·5
	Junkseilon, or Salang I., NS 8 l., (a high mt. vis. 12 l.), S pt., Lem. Voalan	7 46·4	98 18·2
	— Puket, town, ⊞, r, w	7 51	98 20·2
	Pulo Rajah, or Taya, 1064f.	7 36	98 22
	Brothers, 2, NS 3m., S pt.	7 28	98 18·5
	Sangald, or Guilder rks., rf, *l*, T	7 10	98 49·5
	Telibon I., ⊞, r, SW part	7 13	99 24
	Batong Is., 2, E or Dome, 2815f.	6 32	99 19
	Pulo Ladda, [5m.], Bass Harb., ⊞. peak, 1000f.	6 12	99 44
	Queda, town, ⊞	6 6	100 18
	Preparis I., 2/12 8m., T E, ⚓, reef off E side S pt.	14 50·5	93 39
	Great Coco I., NS 6m., ⚓, ⚓, b, w? lt. oo Table I., F 195 f.	14 12 5	93 22·2
	Little Coco I, NS 2½m., ⚓, ⚓ S pt.	13 58	93 13
	Great Andaman, Port Cornwallis, Bush Id., ⊞	13 17·5	93 2
Andaman Isles	— Saddle Hill, 2400f. N pk.	13 12	93 0
	Sir Hugh I, S extr.	11 47	93 4 7
	— Port Blair, Chatham I.	11 41·2	92 43·0
	— Ross I, lt. F 159f.	11 41	92 45
	Sisters, 2, [1m.], E one	11 11·2	92 45
	Brothers, 2, 4/4 3m., N one	11 4	92 39 2

MARITIME POSITIONS

Region	(63) Places	Lat. N	Lon. E
Nicobar Isles	Little Andaman, NS 7 l., ⚓, S bay, (P, w N pt.)...	10° 33′5	92° 28′5
	S. Sentinel, [1m.], 6 l., ⚓ ..	11 2·5	92 12·5
	Flat Rock, [30 yds.], 8f. (on Invisible Bk.)...............	11 8	93 30·2
	Volcano or Barren I., 1158f....	12 15	93 50
	Narcondam, T, 2330f.	13 25 8	94 16
	Kar Nicobar I., Sawi B.	9 14·2	92 45·7
	Batti Malv, or Quoin, [1½m.], ✳, w₀, 150f	8 49·7	92 51
	Chaura, [1½m.], ⚓, 343f........	8 27	93 2·2
	Teressa, 4/4 4 l., ⚓, 897f, S pt............................	8 12	93 11
	Tilangchong, EW 4 l., ⚓, Maharani Pk., 1058f.......	8 29·7	93 37
	Kamorta I., 238f., Naukauri Hr., Naval Pt...............	8 2	93 32
	Kachal I., 835f. pk.	7 57	93 23
	Meroe, small, *l*	7 30·7	93 31·7
	Little Nicobar, 4/4 4 l., ⚓, Mt. Deoban, 1428f.	7 20	93 40·7
	Grt. Nicobar, 2165f., Kondul I., 400f.....................	7 13	93 42
	— Pygmalion Pt.	6 45	93 49·5
	STRAIT OF MALACCA.		
Strait of Malacca.	Pulo Pera, vis. 7 l., ✳₀, T ...	5 42	98 56·7
	Penang I., NS 4 l., sum. 2713f.	5 25	100 14
	— George Town, ⊞, [b], fort Cornwallis, lt. Rev. 107f. .... ⊕	5 24·5	100 20·2
	Saddle I., [½m.]..................	5 13	100 10
	Pulo Dinding, 4/4 2m., *h*, ⚓, w E, Port Pancore, lt. F...	4 13 3	100 34 2
	Salangor fort, lt F...............	3 20	101 12
	Sumbelan, or 9 Is., 4/4 7m., vis. 7 l., ⚓, white rk.......	4 2	100 30
	Jara I., [½m.], T, ⚓	4 0	100 9
	Parcelar hill	2 52	101 25
	Round, or S. Arroa, *h*, ⚓, (rks. off)......................	2 49	100 35
	C. Rachado, ⊥, ⚓, lt. F 446f.	2 24	101 51
	Malacca, St. Paul hill, lt. F 180f.	2 12	102 15
	Water Is., *h*, ⚓, large or S, w	2 4	102 19
	Mt. Moar, *h*, ⚓	1 59	102 40
	Mt. Formosa, (bk. WSW 2 l.)	1 49	102 54
	Po. Pisang, ⚓, lt. Fl. 325f ...	1 27	103 15
	SINGAPORE, [b], FULLERTON BATTERY......................	1 17·2	103 51·2
	Pt. Romania, (Is., 3m. out) ...	1 22	104 16
	Barbukit hill, 645f.	1 24	104 11
	Pedra Branca, T, NW, δ S, Horsburgh, lt. Fl. 101f.	1 20	104 24·6
	Bintang hill, 1260f.	1 5	104 26
	— Black rk.	1 14·5	104 34
	WEST COAST SUMATRA.		
	Po. Rondo, (*Tepurong*), 426f. rks S d	6 3·5	95 7·7

Region	(64) Places	Lat.	Lon. E.
		North	
S. W. Coast of Sumatra	Pulo Wai 4/4 3 l., vis. 12 l., T S, S pt.	5° 46′5	95° 21′
	Buru I., or Malora lt. F 62f.	5 40·7	95 24·7
	Po. Nancy, (bay S, w, b, ⚓,), N pt.	5 40	95 10
	Pulo Brasse, *h*. N, lt. Rev. 525f.	5 45	95 4·2
	Golden or Queen's Mountain, 8280f.	5 22	95 45
	Achen Hd., or King's Pt., *h*, ⊥	5 31·5	95 13·2
	Rajah Passage	4 50 7	95 24
	Rigas Bay	4 38·3	95 34 2
	Bubu Bay	4 12	96 1
	Analabu, w, r, b	4 8·2	96 7
	C. Felix, *l*, T....................	3 44	96 36
	Susu, Po. Kio	3 43·3	96 45 7
	Goonung Loo e, 12,140f.	3 44	97 7 2
	Tampat Tuan Pt.	3 15	97 10
	Teumon Road.....	2 46	97 37
	Sinkel pt. .... ⊖	2 16·8	97 44 7
	Cocos Is., 2, *l*, ⚓ .... ○	3 0	95 18
	Pulo Simalla, 6/5 17 l., N pt. ○	2 57	95 47
	— South pt. .... ○	2 19	96 22
	Flat Is., 2, (small), S pt. ... ○	2 3	96 35
	Banjak Is., Middle Is., Po Sorong Alu..................	1 58	97 21
	Pulo Lakotta, *l*, ⚓	1 51·5	97 59
	Pulo Babi .... ○	1 41	97 27 2
	Pulo Nias, 2/2 22 l., W pt., Tanjong Letang .... ○	1 24	97 1
	— South pt., ⊞, r, w, Telok Dalam .... ○	0 33	97 50
	Nako Is., Asu.....................	0 54	97 11
	Tapanuli B., I., ⊞, Siboga ...	1 44 4	98 45·7
	Pulo Dua..........................	1 28·5	98 9
	Tabujong Road	0 51	98 55 5
	Natal B., δδ, Natal .... ⊖	0 33·5	99 6
	Ayer Bangies, Po. Panka... ⊖	0 8	99 16 5
	Po. Pinie, Batu Belobang, 2/2 3 l. .... ○	0 9	98 30
	Mt. Ophir, 9472 f. .... ○	0 5	99 58
	Tanah Massa I., N pt. ...... ○	0 2	98 22
		South	
	Po. Bojo, lt. Fl. 361f.......... ○	0 39	98 32
	Siberoet, N pt. Sigeb	0 55	98 55
	— West I. .... ○	1 55	99 12
	Sipora I., Hurlock Bay	2 2	99 33
	— S pt., C. Marlborough ... ○	2 24	99 49
	N. Pagi I., N pt.	2 32	100 0
	— SW pt, or Pt. Batu ...... ○	2 49	99 57
	S. Pagi I., S pt. Sibaru I.......	3 20	100 25
	Trieste I., Po. Mega, [1½m.], *l*, ⚓	4 0	101 1
	Engano I, 4/4 7 l., P, W pt., Komang	5 21	102 5
	— South pt., Kenemei	5 31	102 9 5
	Priaman, fl. st.	0 38	100 6
	Padang I, lt. Rev. 180f. ... ⊖	0 57	100 7
Sumatra	Pulo Baringin	1 55 5	100 39
	Indrapura Pt., *l*, ⚓	2 10	100 50
	Moko Moko	2 34	101 8
	Bencuolen, lt. F	3 47	102 16
	— Po. Tikus, lt. F 44f	3 50	102 11
	Mana Pt.......................... ○	4 31	102 54 5
	Kawur or Sambat .... ○	4 50	103 24
	Pulo Pisang, [1½m.], lt.	5 7	103 49 5

MARITIME POSITIONS

Strait	(65) Places	Lat. S	Lon. E
	Kroe Road, w. r ○	5°11′	103°56′
	Bengkunat B., rky. S pt.	5 35	104 14
	Little Fortune I., [1m.]. l, ✝	5 57	104 24
	STRAIT OF SUNDA		
Strait of Sunda	Flat Pt., lt. Fl. 213f. ○	5 55	104 33·5
Strait of Sunda	Labuan I, 4/4 7m., W end	5 47·5	104 47
Strait of Sunda	Keyser's Pk., 7412f.	5 26	104 40
Strait of Sunda	Kalambayang Harb., ⊞, w, r. Klapa I.	5 46·2	105 2·2
Strait of Sunda	Pulo Lagundi, ⊞, mid. N side	5 50	105 17·2
Strait of Sunda	Telok Betung, lt. F 48f.	5 28	105 15·7
Strait of Sunda	Rajah Basa, w, r, pk., 4235f.	5 47·5	105 39
Strait of Sunda	Hog Pt.	5 55	105 43
Strait of Sunda	Java Head	6 47	105 11
Strait of Sunda	Mew B., w‴, SE of Mew I., P.	6 45	105 15
Strait of Sunda	Prince's I., 4/4 4 l., N and E pt., 1450f.	6 31	105 15
Strait of Sunda	Krakatoa, pk., 2657f.	6 9	105 27
Strait of Sunda	Sea rks., Gap rk	5 59	105 23
Strait of Sunda	Sebooko, 4/4 3m., 1398f., N pt.	5 51·5	105 32
Strait of Sunda	Thwart the Way, or Sangian I., 4/4 2½m., l, (rks. 2m. NW), pk. 505f.	5 58	105 49·7
Strait of Sunda	Anjer, ✝, w, r., (lt. SW-d), fl. st	6 3·2	105 55
Strait of Sunda	St. Nicolas Pt.	5 52·5	106 2
Strait of Sunda	North Id., small, vis. 7 l.	5 42	105 50
Strait of Sunda	Thousand Is., Northern-most Dua I.	5 24·5	106 28
Strait of Sunda	— Peblakan, or W. Id.	5 28·5	106 23
Strait of Sunda	Arnemuiden rk., [½m.], 10f., ~	5 13	106 44·2
Strait of Sunda	North Watcher, small, ✝, (Omega shl, E′ b S′ ½m., δ T), lt. R. 159f.	5 12·5	106 27
Strait of Sunda	Two Brothers, ✝, ∥₀, N one	5 9·5	106 6
Strait of Sunda	Lynn shl., [1c.], d, T	5 12	06 12
Strait of Sunda	Brouwers shls, 2 rfs, [¼m.]	5 4·7	106 16
Strait of Sunda	Shabbunder shl., E lim.	5 7	105 59
	STRAIT OF SUNDA TO SINGAPORE.		
	Tree I, N pt.	3 46	105 54
Banka Strait	Lucipara I., [1m.], ✝, w′, (rf. SSE, 2m.)	3 13	106 13
Banka Strait	First Point, l, level, ✝	3 0	106 3
Banka Strait	Banca, S extr., Dapur I. 120f	3 8	106 31
Banka Strait	— Parmesang hill, 1608f.	2 35	105 56
Banka Strait	— Nangka Is., 3, great one, w, b, N pt. 285f.	2 23	105 45·5
	— Monopin Hill, 1456f.	2 1	105 11
	— Kalian Pt., lt. F 170f.	2 5	105 8
	— Frederic Hendric rks.	1 58	104 58
	— North or Mengkudu Pt., islet	1 29·3	105 53·5
	— Goonung, or Mt. Marass, E sum., 2300f.	1 52	105 52
	— E extr., Berikat Pt., 660f.	2 34	106 51
	— Entrance Pt., (SE extr. of Lepa), Murong	3 2	106 54
	Fairlie rk., [½c.], 3f., T	3 27	107 1
	Sand I., [1 l.], β all round	3 30	107 10

Strait	(66) Places	Lat.	Lon. E
		South	
Strait of Gaspar	Shoal-water I., lt. F 200f.	3°19′·2	107°13′·2
Strait of Gaspar	Vansittart shls., NS 3 l., S pt.	3 10	107 6
Strait of Gaspar	Saddle I., Klamban, 266f.	3 2	107 11
Strait of Gaspar	Table I., Goesik, 116f.	2 59·8	107 17
Strait of Gaspar	Pulo Leat, 4/12 6m., Alceste (wrecked there), lt. F 39f.	2 49	107 1·2
Strait of Gaspar	Long I., EW 10m., W pt	2 52	107 21
Strait of Gaspar	Billiton, Po Selio, to SW [4m.], S pt. 242f.	3 15·5	107 32
Strait of Gaspar	— S point, Kalumpang, (shl. 1m. out)	3 16·4	107 59·5
Strait of Gaspar	— Shoals on E side E. Protet	3 3	108 31
Strait of Gaspar	— Burung Mandi Pt.	2 45·3	108 16·7
Strait of Gaspar	— North-west I., Longwas, lt. F 200f.	2 32·3	107 38
	Carnbee shl., rks	3 34·2	107 41
	Canning's rk, [½c.], 3, T, δ	2 23	107 15·5
	Gaspar I., [1½m.], 812f.	2 25	107 5
	Tree I, [1m], 40f., 2 or 3 ✝	2 28	106 59
	Warren Hastings rf.	2 22	106 56·5
	Belvidere rk, 10f.	2 12	107 2·5
	Stttard rf., 3, δ	2 12	106 46
	Magdalen shl., [1c.], 2, T, crl.	2 2	107 0·5
	Newland shl., 2, δ, T ⌐	1 52	107 1·5
	Palmer shl. ○	1 58	106 24
	Severn shl, [3m.], 10f. ○	1 37·6	106 31·5
	Deva rfs	1 10·2	106 46·2
	Vega shl., [¼c.], 9f., T δ ○	1 7·5	106 37·5
Carimata Strait	Shoe I., Kebatu, 346f	3 47·7	108 4
Carimata Strait	Discovery, West bk, [1m.], ld.	3 39	108 45·5
Carimata Strait	— East bk., [½m.], ld., 2 ✝	3 35	109 11
Carimata Strait	Osterley shls., [6 l.], N one	3 17·7	108 38·2
Carimata Strait	Cirencester bk., [½m.]	3 16·2	108 59·2
Carimata Strait	Montaran Is, EW 12 l., NE extr. or Catherina rf.	2 30·7	108 55·2
Carimata Strait	W. grp., Nangka I., pk. 549f.	2 30	108 33
Carimata Strait	Ontario rf., [½m.], T, δ (a coral rf. W 3m., 3)	1 59·5	108 39·5
Carimata Strait	Serutu, EW 2 l., 1575f., w, W end	1 43	108 41·2
Carimata Strait	Carimata, [3½ l.], w, b, pk. 3378f.	1 36	108 54·5
Carimata Strait	Penebangan, 6/6 2 l., h, w′, pk. 1722f.	1 24	109 15
Carimata Strait	Greig Shoals, N. Greig	0 52·5	108 32·5
Carimata Strait	Greig shls., Gwalia	1 5·7	108 34·5
Is. N.W. of Banka	Pulo Toty	0 54·5	105 46
Is. N.W. of Banka	Pulo Docan	0 58	105 39
Is. N.W. of Banka	Po. Tudju, or Seven Is., 4/12 8m., ✝, NW one	1 8	105 14
Is. N.W. of Banka	Pulo Varella, (Is. [3m.]), 4501	0 48	104 24
Is. N.W. of Banka	Pulo Taya, [3m.], 630f.	0 43·6	104 54·2
Is. N.W. of Banka	Po. Sinkep, S pt. C. Bulu	0 38	104 22
Is. N.W. of Banka	Alang Kalem, [2m.], 1	0 24	104 57
Is. N.W. of Banka	Linga I., 4/6 sum. 3921f.	0 11	104 32·5
Is. N.W. of Banka	East Domino, [1m.]	0 6	104 58
		North	
Is. N.W. of Banka	Pollux rk., 2	0 12·5	104 44·5
Is. N.W. of Banka	Terobi, 112f.	0 42·4	104 47
Is. N.W. of Banka	Frederick rk., [3c.], 2, ββ	0 38·5	105 10·7
Is. N.W. of Banka	Pulo Panjang, EW 4m., 390f., E pt.	1 1	104 51·2

MARITIME POSITIONS

Region	(67) Places	Lat.	Lon. E
Sumatra, N.E. Coast	Batacarang Pt.	South 2° 0′	104° 51′
	Jabong Pt.	0 56	104 23
	C. Baroe	0 1	103 48·5
	Rhio Str., Garras I., W side entr., lt. F 121f.	North 0 46	104 21
	— Pulo Sau, lt. F 108f.	1 4	104 10
	Gt. Carimon, S pk., 1474f.	1 5	103 19
	Little Carimon, … 3m., …, T NE, N pk., 1062f.	1 8	103 22
	Bucalisse I., *l*, NE pt.	1 34	102 23
	Pulo Roupat, N pt., T	2 6	101 39
	Reecan R., Lalang Besar I.	2 10	100 34
	N. and S. Brothers, … 5m., …. N one	3 24	98 46
	Battoo Barra R.	3 13	99 34
	Pulo Varellah, 8 I., …, b, P,	3 47	99 30
	Delhi R.	3 46	98 41
	Prauhilah Pt, (rf. 3m.)	4 53	97 52
	Diamond Pt., *l*. … ⊕	5 16	97 30
	Pedir Pt., or Batoo Pedir ⊕	5 29·5	95 55·2
	Pt. Pedro ⊕	5 39	95 27·2
	CHINA SEA.		
Entrance of China Sea	Pulo Tingy, …, w w₀, sum. 2046f.	2 18	104 8 5
	Pulo Aor, … 2½m., 1805f.	2 28	104 31
	Pulo Pemangil, 1507f.	2 36	104 19
	Pulo Tioman NS 10m., 3444f., N pt., r₀, b, w, P,	2 55	104 10
	St. Barbe, [3m.], *h*, w, 752f.	0 8·1	107 13·5
	Direction I., sum. 639f.	0 14·3	108 2
	Pulo Datoo, *h*, SE pt.	0 8·2	108 36·2
	Green Id., centre	0 44 7	107 19
	St. Esprit Is., … 4 l., 817f.	0 37·5	107 1
	Wellstead rk., 3	0 32 4	107 53
	Ellen shl., rks., [½c.], sf.	0 41·2	107 31·2
	St. Julian, summit 537f.	0 55·7	106 43 5
	Tambelan Is., … 6 l., f, Great, summit 1300f	1 1·0	107 32·2
	— Gap rk	1 12·5	107 34·5
	Europe shl., rt., [1m.]. 3	1 11·3	107 25·5
	Camel I., summit 574f.	1 11·7	106 53
	Saddle I., summit 307f.	1 19·3	107 2·2
	Barren I., summit 80f.	1 31·7	106 25·5
	Victory I., summit 285f., 8 l.	1 34·7	106 18·5
	Acasta rk., 2f., T	1 39	106 19
Anambas	**White rk.**, *h* 110f.	2 18	105 35
	Repon, 695f.	2 21·6	105 53
	Pulo Domar, 270f, …, T	2 44·5	105 23
	Djimaja, … 5 l., S pt.	2 48	105 43
	Tokong Belauer, Pillar rk.	3 27	106 16
	Pulo Selei, 480f.	3 12	106 30
Natunas	St. Pierre Is., 2	1 51·7	108 39
	S. Haycock I.	2 17	108 54
	Sirhassan Id, Ko i Hd., 765f.	2 33	108 59 5
	Kepalon	2 39 5	109 10
	West I, 865f., N end	2 43·5	108 35
	Soubi I., N end, 200f.	3 3	108 51
	Jackson rfs., E extr.	2 56	107 56
	Low I., [1 l.], N end	3 1	107 48
	N. Haycock I., *h*, rf., S-d	3 16	107 34
	Elphinstone rk., [1m.], 70f.	3 23	107 51
	S extr., Sededap I., *h*	3 33	108 3

Region	(68) Places	Lat. N	Lon. E
Natunas	Great Natuna, NS 40m., N pt.	4° 16′	108° 11′
	—Mt. Ranay, on E side, 1890f.	4 1	108 19
	Micalle rf.	4 4	108 25
	Selouan I., [1 l.], S sum.	4 8	107 49
	Low pyramidal rks., 25f.	4 3	107 21
	Success breakers, [2m.]	4 23	107 53
	Semione, or Saddle I.	4 31	107 42
	N. Natunas, …, N islet	4 51	108 2
Gulf of Siam	Blair Harbour, ⊞	2 38	103 47
	Pulo Varela, rk., …, rf. 2m.	3 19	103 38
	Howard shl., 1	4 17	103 38
	Pulo Brala, 10 l., rks., N 5 l.	4 49	103 39
	Pulo Capas	5 13	103 14
	Tringano R., w, r, bar	5 21	103 6
	Great Redang I., pk.	5 46	103 1
	Pulo Lantinga	5 50	102 52
	Printian Is., outer one	5 55	102 44
	Pulo Lozin, small, 7f.	7 21	102 0
	Kalantan R., bar, w′	6 12	102 19
	E. Patani Pt.	6 58	101 17
	Koh Krah, grp., large one	8 25	100 44
	Carnom Pt.	8 56	99 49
	Sumni I, [2 l.?], 2000f. sum.	9 33	100 1
	How Luang, Mt., 7m. inland, 4326f.	11 38	99 33
	Koh Tarkut (Po. Cin ?) (peaks, 1815f., … 5m.)	12 12	99 59
	Bangkok R., lt. F 44f.	13 29	100 35
	Bangkok, Brit. Factory	13 44·6	100 28·2
	Siam, now Ayuthia, mid.	14 22	100 36
	Koh-si-chang I., NS 4m., w′, N pt.	13 11	100 47
	Koh Leum I., [¾m.], 445f.	12 57·5	100 38
	C. Liant	12 35	100 57
	Chalan I., [1c.], 40f., T, δ₀	12 28	100 57
	Cawshaff Mt.	12 31	103 4
	Junk Rock Pt.	12 8	102 47
	Kusrovie rk.	11 7	102 45
	Samit Pt.	10 52	103 7
	Bumba town	10 35	104 10
	Teeksia R., mouth	10 6	104 54
	Cambodia Pt.	8 35	104 42
	Po. Way, 2 Is., … 1m, 250f.	9 55	102 52
	Pulo Panjang Is., EW 3m., 550f., w, b, r, great one	9 18	103 27
	Pulo Oby, … 2¼m., w, 1046f.	8 25	104 48
Cochin China	Saigon, City	10 46 7	106 42
	C. St. James, δ 3m., lt F 482f.	10 19 8	107 5
	Britto shl., [1¼m.], 4, T	10 29	107 49 5
	Pt. Kega, δ₀, (Mt. Taicon, *h* …)	10 42	108 0
	Ceicer de Terra, *l*, …, δ 3m.	11 14	108 48
	C. Padaran, *h*, …, T, lt. Fl.	11 23	109 1
	False C. Varela, (Camranh Harb., ⊞), *h*	11 44	109 13
	Pyramid I., *h*	12 17	109 20
	Nhatrang B., ⊞, w, b, riv., bar, 7f., Tree I, pk. 1640f.	12 13	109 16
	Three Kings, rks., T, Hone-Cohe harb., ⊞, w, 15f.	12 34	109 27
	C. Varela, or Pagoda C., *h*, T, pt.	12 55	109 26
	Perforated rk., rks.	12 58	109 25 5
	Conical Mountn., 1870f.	13 11	109 10
	Phuyen Harb., ⊞, Nest I.	13 23	109 15

MARITIME POSITIONS

	(69) Places	Lat. N	Lon. E
Cochin	Conmong Harb., ⊞, Gainba Hd.	13°31′	109°16′
	Pulo Cambir, $\frac{2l}{2}$ 3m., 6 l.	13 37	109 19
	Quinhone Harb., ⊞, C. Sanho, *h*, ⊥	13 45	109 16
Islands in the China Sea	Charlotte Bk., [3m.], ₅, T ...	7 7·3	107 37
	Brothers, $\frac{1}{4}$ 3m., E one, *h*, ✦ ...	8 37	106 9
	Pulo Condore Is., [3 l.], ⊞, w, r₀. 1954f., lt. F 696f....	8 40	106 41
	Royal Bishop, $\frac{5}{8}$ 32m., ₁₀	9 40	108 14
	Lit. Catwick, summit 56f.	9 59·5	107 4
	Great Catwick, ✱₀, ⌒, 196f ...	10 2·9	108 55
	Ynsun shl., ₄	10 16	109 2·2
	Pulo Sapatu, ✱₀. ⌒, 346f. ...	9 58·4	109 6
	Holland bk., ₂₅, T, centre ...	10 39	108 43
	Pulo Ceicer de Mer, $\frac{1}{4}$ 3½m., r., highest peak 360f.......	10 32	108 56
	Vanguard shl , E and W 7 l. ₈	7 28	109 43
	Graingcr shl., ₈	7 47·8	110 29·5
	Prince of Wales bk., ₄, S part	8 3	110 30
	Prince Consort bk., ₁₀, from	7 46	109 55
	— to	7 58	110 6
	Rifleman bk., ₁₁f., SW end	7 31·5	111 32
	— NE „	7 57·5	111 45
	Amboyna Cay, centre	7 51·8	112 55·5
	Owen shl., [2m.], crl., ₄	8 8	112 0
	Spratly or Storm I., 8f.	8 38	111 55·2
	Ladd rf.	8 40·3	111 39
	London rfs., W reef—cay... ⊕	8 51·9	112 15·5
	— central rf., d. .... ⊕	8 55	112 21
	— East rf., E extr............ ⊕	8 49·5	112 38·2
	— Cuarteron rf, d............ ⊕	8 51	112 50
	Fiery Cross rf., $\frac{1}{4}$ 15m , I. or NW Investigator, SW bank, beacon ...... ⊕	9 35	112 54·5
Islands and Shoals N.W. of Borneo	Luconia breakers, South	5 3	112 42
	— shls., Seahorse breakers ...	5 31	112 33
	— Friendship shl., [3 l.], ₄, N pt.	5 58	112 31
	Louisa shl., [3m.] rks., T mid.	6 20	113 18
	Royal Charlotte shl., [1½m.], rks............. ○	6 57	113 35
	Swallow shl., [4m.], rks. at E pt	7 23	113 50
	South Viper shl.? .... ○	7 30	115 0
	North Viper shl. ? .... ○	8 0	115 25
	Ardasier shl., ₂₁	7 37	114 10
	— Glouccester shl. .... ○	7 50	114 14
	SW Shoa .... ○	8 0	114 50
	Investigator, rf., EW 5 l., W pt. .... ○	8 5	114 35
	Cay Marino ? .... ○	8 30	114 20
	S. Cornwallis shl. ?........... ○	8 52	114 12
	Pearson shl., rks., NS 2m. ○	8 56	113 44
	Ganges .... ○	9 25	114 10
	Sin Conn I.................... ○	9 42	114 22
	Discovery, Great rf., NS 7m., d., N end .... ⊕	10 7·5	113 53
	— Small rf., d. .... ⊕	10 1	114 2
	Westero or Flora Temple... ⊕	10 15	113 37·5
	Tizard Bank, Itu Aba I. ... ⊕	10 22·5	114 21·5
	— Nam Yit I. .... ⊕	10 12	114 22
	Eldad rf.	10 23	114 42
	— Gaven rf.	10 13	114 13

	(70) Places	Lat. N	Lon. E
Islands and Shoals N.W. of Borneo	Pennsylvania .... ○	9°59′	115°11′
	— Another do. .... ○	9 5	115 17
	Half Moon shl., $\frac{4}{4}$ 3m., S pt.	8 52	116 15·5
	Royal Captain shl., rks.	9 1	116 39
	NE Investigator .... ○	9 12	116 30
	Pennsylvania .... ○	9 32	116 28
	Bombay shl., rf., W pt., T ...	9 26	116 56
	Sabina shl. .... ○	9 42	116 38
	Pennsylvania, shls., [4 l.], mid. .... ○	9 49	116 47
	Pennsylvania .... ○	10 0	115 12
	Ganges .... ○	10 18	115 5
	Loai-ta I. and rfs., S. I., ✦ ⊕	10 40·5	114 25·5
	— Cay, W end .... ⊕	10 44	114 21
	Souhie rf., d., centre .... ⊕	10 55	114 7
	Thitu I. and rfs., W end ... ⊕	11 2	114 11·5
	Trident shl., N end, d. ...... ⊕	11 31	114 39·5
	North Danger, a ✦, 2 islands, 10 to 15f.	11 28	114 21
	Brown, ₅ .... ○	10 30	116 39
	Brown, shl. .... ○	10 35	116 58
	Brown, shl., [3 l.], ₅, a flat, mid. .... ○	10 43	117 20
	North Pennsylvania .... ○	10 52	116 55
	Carnaic shl., ₃ .... ○	10 6	117 26
	Auckland, ₈, T .... ○	10 20	117 20
	Fairy Queen, ₉ .... ○	10 34	117 39
	Seahorse or Routh bk., $\frac{2}{7}$ 9m., ₄₁	10 50	117 47
	Templar bk., NS 4m , ₁₀ ... ○	11 7	117 21
	Cochin China continued from (69).		
Cochin China	Buffalo I., or rk., T, 98f.	14 9	109 16
	Turtle I., small, *l*	14 22	109 10
	Tamquam R., bar	14 35·5	109 2
	C. Batangan	15 16	108 54
	Pulo Canton. vis. 9 l., rf. SE, w	15 23	109 6
	Qui-Quik, ⊞, w, C. Bantam...	15 25	108 47
	Col'ao Cham, False, Honong, *h*	15 49	109 39
	Collao Cham I., $\frac{2l}{2}$ 5m., *h*, ‡' W, summit 1230f......	15 57	108 30
	C. Turon	16 7	108 19
	Turon Bay, ⊞, w, r, Turon I	16 5	108 12
	C. Choumay, West C.	16 20	107 54
	R. Hue Fo, bar ₂, fort, W entr.	16 33	107 38
	Tiger I., [1m.], 230f............	17 9	107 19
	S. Watcher, 272f.	17 55	106 39
G. of Tuquin	Hon Tseu, Goat I., 475f.	18 6	106 26
	Hon Mat. Eastern I., 144f. ...	18 49	105 58
	Vinh, fort at entr. Ngan Ka R.	18 47	105 43
	Lacht Kuen Harbour...........	19 4·5	105 41
	Hon Mè I.	19 20·5	105 57·5
	Thunh-hoa town	19 48	105 45
	Song Ka River, Ninh Lacht Custom Ho.	20 8·5	106 14
	— Fort Ba Lacht	20 19	106 27
	Nightingale I., Batchloog vi. ...	20 7	107 41
	Hon Dau, lt. F 148f.	20 40	106 47
	Norway Is., S rk.	20 37	107 8
	Laitao I., S pt.	20 43·5	107 25
	Kua Doi or Bamonn	20 58·5	107 30·5

MARITIME POSITIONS

(71)	Places	Lat. N	Lon. E
G. of Tonquin	Gautau Is., E cape	21° 2′	107° 50′
	Loshushan I., 804f.	21 14	107 55 5
	C Paklong	21 29·5	108 11
	Long Moun R., Ouloi Pt.	21 36	108 43 5
	Pakhoi Kwantau Pt., 374f.	21 27	109 2
	Guie Chaw I., pk. 279f.	21 1	109 6·5
	Lui Chew, C. Cami	20 13	109 55
Hainan I.	Hainan I., $\frac{f6}{6}$ 53 l., Hong pi Kok	20 0	109 49
	Double hill pt., Pingmar	19 55	109 17
	Chappu B., Hiongpo fort	19 43	109 12
	Bluff Pt., 120f.	19 21	108 41
	South-west pt., Inkohai	18 32	108 41
	Button I., 256f.	18 20	108 57·5
	Great Cape, 1740f.	18 18	109 12
	Yu-lin-kan B., ⊞, entr. to inner harb.	18 13	109 33
	C. Bastion, 863f.	18 9	109 36
	Liong-soy Pt.	18 22·5	110 3
	Tien fung rk., rks., ‖ W, T	18 26	110 8
	Tinhosa Is., NS 2½m., 1609f., T E, N sum., (w_o)	18 42	110 28 ?
	False Tinhosa, 150f.	18 50·5	110 34
	High Mountain, 3 pks., 2040f.	19 2	110 23
	Mt. Toncon, 1229f.	19 40	111 1
	Mofou Pt.	20 1	110 55
	NE pt., or Hainan Head	20 10	110 41
	Hoihau, W fort	20 3 2	110 19·5
	Taya Is., 648f., ‖ W, N one	19 58·8	111 16
Paracel Is.	Triton I., $\frac{4}{4}$ 4m, N part 26f.	15 47	111 14
	Bombay shl., $\frac{f6}{6}$ 4 l., rks., T, mid.	16 3	112 32
	Discovery rf., $\frac{f6}{6}$ 5 l., T, E extr.	16 14	111 54
	Crescent Chain, 6 Is., *l*, EW, Observation Bk.	16 36	111 44
	North shl., $\frac{f6}{6}$ 2 l., T, E pt.	17 3	111 36
	E extr., Dido	16 49	112 54
	Lincoln I., [1 m.], rfs. 1 m., *l*, ✱, w	16 40	112 44
	Amphitrite Is., 2 grps., $\frac{2}{12}$ 3 l., ‖, Tree I.	16 58	112 17
	Macclesfield shl., coral, EW 23 l., 8 to 50, supposed growing, W extr.	15 41	113 43
	Scarborough shl., S rk. 10f.	15 5	117 49
	St. Esprit shl., 7	19 33	113 2
	Helen shl., 6)	19 12	113 54
	Pratas shl., [7 l.], rks., δ, Id. at W part, 40f.	20 42	116 42·5
	CHINA, SOUTH AND EAST COAST.		
	Hainan B., conical mound, 80f.	20 14·5	110 16 5
	Black rks.	20 29 5	110 32·5
	Nau Chau I., 274f.	20 54	110 36
	Hai-ling-shan I., $\frac{4}{4}$ 4 l., Mamechan I.	21 34	111 47
	Mandarin's Cap, *wh.*, ✱₀, 200f.	21 28	112 22
	Passage I., E entr., Namoa, ⊞	21 35	112 34
	Wizard rks., outer grp., 30f.	21 47	113 1
	Tylon I., *h*, *wh.*, patch E, T, S pt.	21 52	113 15
	Grand Ladrone, [2m.], 1, 9	21 57	113 43

(72)	Places	Lat. N	Lon. E
	Haipong I., $\frac{f6}{6}$ 3m., S part, Asses' Ears	21° 54′	114° 0′
	Great Lema, $\frac{f6}{6}$ 6m., w, E pt.	22 5	114 19
	Lautao pk., 3050f.	22 16	113 58
	Macao, Guia fort, lt. Rev. 332f.	22 11·4	113 38
	Canton, English factory	23 6 9	113 15·0
	Hong Kong, $\frac{f6}{6}$ 9m., Victoria, N side, Cath. [h]	22 16 9	114 9 5
China, S. Coast	C. Collinson, lt. F 200f.	22 15·7	114 15
	Mirs Bay, ⊞, rk. mid. entr	22 27·5	114 25 5
	A high summit, 2810f.	22 31	114 32
	Single I., [3c.]. T	22 24	114 40
	Mendoza I., [1m.], T, 480f.	22 31	114 50
	Fokai Pt., sum. N 1m., 670 f.	22 34	114 54
	Pedro Blanco, *h*, T	22 18 5	115 7
	Whale rk., small, T	22 30·5	115 0
	Che lang piah Pt., T	22 39	115 34
	Si-ki rk., 80f., T	22 42	115 46
	Cup-chi Pt., 210f., rks. S 2m.	22 48	116 4 5
	Breaker Pt., *l*, rky., lt. Occ. 152f.	22 56	116 28
	Tonglae fort	22 59·5	116 31·5
	C. of Good Hope, lt. Int. 171f.	23 14 5	116 48·5
	Swatau lt. F. Fl. 200f.	23 19·9	116 45·5
	Namoa I., EW 12m., 1934f.	23 26	117 4·5
China, S.E. Coast	Lamock Is., $\frac{4}{4}$ 8m., Boat rk.	23 11·4	117 14
	Table Hill, 1767f.	23 39	117 9
	Chelsieu rks., [1m.], 20f.	23 29	117 15
	Brothers, 2, $\frac{4}{4}$ 2m., S one	23 32·5	117 42
	Tonsang Harb., ⊞, entr., pagoda	23 44	117 33
	South-east I., [1m.]	23 47	117 43
	S Merope shl, $\frac{f6}{2}$ 5m., 5, S pt., T	24 6	118 6
	Chapel I., ⊥, lt. F, Fl. 227f.	24 10·3	118 13·5
	Chauchat rks., *l*, E extr.	24 21	118 9
	Amoy, ⊞, Kulangseu Semph.	24 26 8	118 4·0
	Quemoy I., $\frac{4}{4}$ 10m., S pt.	24 24	118 19
	Dodd I., [1c.], lt. Occ. 147f.	24 26·1	118 29·2
	West Peak, a Mk., 1714f.	24 40	118 20
	Hoo-e-tow Pt., 80f.	24 31	118 33
	Chimmo, (South), Pagoda I.	24 38	118 40
	Mt. Keu-sau, pagoda, 760f.	24 43	118 38
	Chung-chi Pt., 400f., (rks. off)	24 40	118 46
	Chin chu, ⊞, Passage I.	24 50	118 49
	Pyramid Pt., (rks. off)	24 52	118 57 ?
	Meichow I., $\frac{f6}{2}$ 5m., S pt.	25 1	119 6
	— Sorrel rk., [½m.], 60f.	25 2	119 9
	Ockseu Is., $\frac{f6}{6}$ 2m., lt. Rev. 286f.	24 58·8	119 26
	Ping-hai	25 11	119 16
	Loutzee rk., [1m.], (rks off)	25 7	119 22
	Lam-yit I., $\frac{6}{6}$ 8m., peak	25 12	119 33
	Yit Is., $\frac{f6}{2}$, E extr., Reef I.	25 18	119 45
	Chimney I., EW 2m., N pt.	25 23	119 43
	South reef, [¾m.]	25 23	119 50
	Turnabout I., [¾m.], lt. F 257f.	25 26	119 57
	Hae tan I., NS 17m., pk. on NE side, 1420f.	25 36	119 49
	Kwing I., [2m.], (off NE part of Hae-tan), E pt.	25 36	119 55
	White Dogs, grp., $\frac{6}{6}$ 4m., Middle Dog, lt. F. Fl. 257f.	25 58	120 1
	Sea Dog rk., small, T E	26 5	119 50
	River Min., Temple Pt.	26 8 4	119 37·7
	Ting-hae	26 18	119 48

MARITIME POSITIONS

Region	(73) Places	Lat. N	Lon. E
China, E. Coast	Matsou I., 6/6 3m., S pt.	26° 9′	119° 56′
	Chang-chi I., 4/4 3½m., 1330f.	26 14	120 0
	Larne rk.	26 16	120 12
	Alligator rk., small, 40f.	26 9	120 24·5
	Tung-ying Is., 4/4 3m., T S, sum. 853f.	26 23	120 29·7
	Double Peak I., 2/2 3½m., w, pk. 1190f.	26 36	120 9·7
	Pih-seang Is., [5m.], N Id.	26 42	120 20·5
	A dangerous rk., ββ₀	26 52·2	120 33·2
	Fuh-yaou I., 6/6 4m., w′ NE, ⊞ W-d. sum. 1700f.	26 56	120 21
	Tae Is., [2 l.], E one, sum. 618f.	26 59	120 42
	Seven Stars, 1ks, [2m.]	27 4	120 49
	Cleft rk.	27 6	120 47
	Nam-quan, ⊞. Bate I.	27 9·2	120 24·2
	Pih-quan Pk., 5m. inland	27 18·5	120 27
	Castellated rk.	27 20	120 57
	Nam-ki I., grp., 4/4 7m., w, 740f., ‡	27 26·5	121 2·5
	Pih-ki-shan Is., EW 4m., Coin I.	27 37·4	121 11·2
	Quoin	27 50	121 13
	Wan-chu-fu, city	28 1	120 36
	Pe-shan Is., [2m.], E one	28 5·5	121 30
	S. Foreland, I., [½m.]	28 16	121 42
	Chik-hok I., [¼m.]. ⊥, 760f.	28 22·4	121 42
	N. Foreland I., [½m.]	28 33	121 37
	Taichow Is., 2/2 9m., S pt., or Fingers	28 23	121 53
	— Shang-ta, grt. one, ẇẇ, N pt.	28 30	121 52
	— North Id., [and rfs., ½m.]	28 32	121 54
	Square I.	28 35	121 47
	Tung-chuh, or Bella Vista, 6/6 2m., sum. 700f.	28 42·2	121 54
	Hai-mun, S of entr. of R. Taichow, citadel	28 40	121 26
	Fall I., [1m.]	28 50	121 50
	Hirshan Is., 2/2 5m., r̄′, S or Saddle I., 320f., w	28 51	122 13
	Eight feet rk., (N of do.)	28 56	122 17
	Triple I., [2c. ?]	28 59	121 53
	C. Conway	-9 3	121 55
	Montague I., 6/6 4m., 740f., E pt.	29 10	122 4
	Sheipoo	29 13	121 55
	Kweeshan Is., [6m.], grt. one, sum 400f.	29 26	122 11
	— Patahecock I., [3c.], *h*	29 22	122 13·5
	— E extreme	29 27	122 15
	Chusan Is., S extr., Tinker rk.	29 36	122 9
	— Taouhwa I., 6/6 7m., sum. 1680f.	29 48	122 16
	— Chookea I., NS 6½m., pk. 1160f.	29 54	122 24
	— Outermost, Tong-ting, [2c.], 161f.	29 51·5	122 35
	Cone I., small	30 4	122 27
	Chusan I., 6/6 7 l., Ting-hae, citadel	30 1	122 6
	Chin Hae	29 57	121 43·5
	Ning Po, pagoda	29 51·7	121 33·5
	Friendly Bluff, Talung I., 980f.	30 6	121 34
	Fisherman's Is., EW, **E** extr., Brothers, T	30 10	122 56

Region	(74) Places	Lat. N	Lon. E
China, E. Coast	Fisherman's Is., Monte Video, 4/4 2m., T, 996f., ✻₀	30° 8′	122° 46′·7
	Steep I., lt. Fl. 243f.	30 12	122 36
	Lukon Is., 313f., [½m.], T	30 26	122 56
	Beehive rk., T, 46f.	30 22	122 41
	Ts i-san I., EW 8m., Pennell Pt.	30 25	122 16
	Childers rk., T	30 37	122 50·5
	Barren Is., [1m.], rky., T, 150f.	30 45	123 8·5
	Saddle Grp., 4/4 13m., E Sad., S pt., T, 692f.	30 42	122 49
	— N. Saddle, EW 2m., T, N pt., lt. Rev. 273f.	30 51·5	122 40
	Rugged Is., EW 10m., SW Horn, 50f.	30 36	121 57·2
	Gutzlaff I., [½m.], lt. F 270f.	30 48·5	122 10
	Yang-tse Kiang, beac. 35f.	30 51	121 52
	Ariadne rks., [1c.]	31 9	122 14·7
	Amherst rks., [1c.], 26f.	31 11	122 22
	Wusung, fort, lt. F 50f.	31 23	121 30
	SHANGHAI, BRIT. CONSULATE	31 14·7	121 29·0
	Nankin, city, porcelain tow.	32 2	118 49
	Hankow, Bouncer I., lt. F.	30 33	114 30
	Sha-wei-shan, rk., lt. F 229f.	31 25	122 14
	Tsung Ming I., 5/5 10 l., E pt.	31 28	121 51
	A shl., pt., NNE 6l.	31 44	121 57
	A shl., 5/5 5m., 2	32 0	122 0
	Is. in G. of Whang-ho, outer ○	33 0	120 40
	Whang-ho, or Yellow R. ○	34 2	120 10
	Hae-chow, city ○	34 35	119 30
	Tower Pt.	36 21	119 33
	Kyau-chau Harb., NE hill	36 3	120 14
	Ka tih-neaou I.	36 11	120 57
	Surveyors I.	36 16	121 24
	Urh Taou, or Staunton I.	36 45·7	122 16·2
	Shan Tung prom., lt. F 220f.	37 24	122 42·5
China, N.E. Coast	Alceste I., small, rks. off	37 27	122 40·5
	Wei-hai-wei Harb., ⊞, N pt., entr., Leucung I.	37 32	122 10
	Che-tow C., ⊞ SE-d.	37 36	121 26·2
	Chung-shan I., S extr., 4/4 7m., S pt.	37 55	120 45
	Miautau Is., Ta-Hi Shan, W pt.	37 58	120 36
	Howki I., lt. Fl. 328f.	38 4	120 39
	N extr., Siao-kin-Tao, [1m.]	38 21	120 51
	Hwang-ching-tau I., EW 2m.	38 23	120 55
Gulfs of Pechili and Liautung	Chimatau Promontory	37 41	120 13
	Laichau Bank	37 28	119 44
	Sharp Pk., 2436f.	37 0	120 0
	Pei-ho R., S Taku fort	38 58	117 43
	Sha-lui-tien I., lt. F 50f.	38 53	118 32
	Great Wall, E extr. Ninghai	39 58	119 49
	Halutan Prom.	40 44	121 2
	Neuchwang	40 43	122 14
	Hulu shan B., N pt.	39 30	121 14
	Iron I., 750f.	38 57	121 0
	Liau-ti shan Promontory	38 43	121 11
	Cap rk., 400f.	38 48	121 35
	Talien Whan Bay, entr. San-shan-tow Is., S extr.	38 52	121 51
	Encounter Rk., 11f.	38 34	121 39

MARITIME POSITIONS

Group	(75) Places	Lat. N	Lon. E
	Round I., small, 200f.	38 40′	122° 12′
	Rock, like a junk, Shi-siau ...	38 56	122 45
	Hai yun-tau I., S pk. 1370f....	39 3	123 10
	ISLANDS EAST OF CHINA.		
Pescadores, or Ponghou Is.	Pescadores Is., Junk I., 260f...	23 12·6	119 25·7
Pescadores, or Ponghou Is.	— East I., N end	23 15·9	119 40
Pescadores, or Ponghou Is.	— High I., 247f.	23 19·2	119 19·5
Pescadores, or Ponghou Is.	— Yih Pan I., N pt.	23 24·2	119 19·5
Pescadores, or Ponghou Is.	— Pachau I., [1½m.], N pt. 158f.	23 23·4	119 29·2
Pescadores, or Ponghou Is.	— Table I., W pt. 180f.	23 28·7	119 30·2
Pescadores, or Ponghou Is.	— Ponghu, I., Makung ⊞, Obs. I.	23 32	119 33·5
Pescadores, or Ponghou Is.	— W pt., Fisher's I.	23 33	119 28
Pescadores, or Ponghou Is.	— North rk.	23 47	119 35·2
Pescadores, or Ponghou Is.	— Round I.	23 32·7	119 42·7
Pescadores, or Ponghou Is.	Nine-feet rf.	23 28	119 45
Formosa	Formosa, S cape, lt. F 180f....	21 55	120 50·7
Formosa	Lambay I., [2½m.], summit ...	22 20·5	120 22
Formosa	Ape Hill, 1110f., Ta-kau	22 38	120 16
Formosa	Fort Zealandia, lt. F 60f.	23 0	120 10
Formosa	Port Kok-si-kon	23 6	120 4·5
Formosa	Wanckan Bank, ⚓	23 31	119 59
Formosa	Table Hill, 360f.	24 54·0	120 57·5
Formosa	Tam-sui harb., ⊞. White Fort	25 10·4	121 25·0
Formosa	Sum Eastward, 2800f.	25 12	121 30
Formosa	Syau-ki Pt.......................	25 18·4	121 31
Formosa	Pinnacle I., [¼m.], ‖ S	25 26	121 57·5
Formosa	Crag I., [1m.]	25 29	122 6·7
Formosa	Agincourt I., [1m.]	25 38	122 8
Formosa	Kelung harb., ⊞, Ruin rk. ..	25 8·6	121 45·5
Formosa	Kelung I., [½m.], 580f.........	25 12	121 48
Formosa	East extreme of Formosa	25 2	122 0
Formosa	San-o Bay, Obs., W side	24 35·5	121 49·5
Formosa	Mt. Morrison, 12,850f.	23 29	120 58·5
Formosa	Blackrock B., outer rk..........	23 6·5	121 25
Formosa	Samasana I., [1m.], rky.	22 39·4	121 27·2
Meia-co-si-ma Is.	Kumi I., I-nah-Kwoh, ⚓ 6m.	24 25	122 59
Meia-co-si-ma Is.	Hummock I., [¼m.], mid.......	24 13	123 36
Meia-co-si-ma Is.	Sandy I., EW 3m., W pt......	24 4	123 49
Meia-co-si-ma Is.	Koo-kien-san I., ⚓ 15m., (w' SW), W lim.	24 18	123 43
Meia-co-si-ma Is.	— N extr.	24 26	123 47
Meia-co-si-ma Is.	Patchusan I., ⚓ 6 l., N pt. ...	24 37	124 19
Meia-co-si-ma Is.	— Port Haddington, ⊞, W pt. entr.	24 25·0	124 5·2
Meia-co-si-ma Is.	Typinsan I., ⚓ 16m., ⚓, E pt.	24 43	125 29
Meia-co-si-ma Is.	— I. off N extr., Ee-ki-mah...	24 55	125 14
Meia-co-si-ma Is.	— I. off SW part, Koo-re-mah	24 42	125 13
	Hoa-pin-su I., 1181f., NE side	25 47	123 29
	Ti-a-usu I., EW 4m., ⚓, mid....	25 57	123 40
	Raleigh rk., 270f.	25 55	124 34
Liu-kiu Is.	Koomisang I., 1108f., EW 8m., (rk. S 2m.), NW pt.	26 22	126 44
Liu-kiu Is.	Tusima I., 60f.	26 35·5	126 51
Liu-kiu Is.	Tunashee I., sum. 603f.........	26 21	127 10
Liu-kiu Is.	Agunyeh pk., 300f.	26 34·7	127 14

Group	(76) Places	Lat. N	Lon. E
Liu kiu Is.	Kerama Is., W one, High I., 916f.	26° 10′	127° 15′
Liu kiu Is.	Great Liu-kiu. Okinawa, ⚓ 19l., Nafakiang, Abbey Pt.	26 13	127 41
Liu kiu Is.	C. Yakimu Pt., (rf. ⚓ 8m.)	26 4	127 41
Liu kiu Is.	— E extr., C. Sidmouth, I. off	26 47	128 21
Liu kiu Is.	— N extr., C. Hope, Heto ...	26 51	122 17
Liu kiu Is.	— Kiu, Herbert I., ⚓ 2½m., entr., Port Oonting or Melville, ⊞, sum. 354f.	26 42	128 2
Liu kiu Is.	Sugarloaf, 8 l, 575f.........	26 43	127 49·5
Liu kiu Is.	Montgomery Is., ⚓ 5l., ⚓, N pt.	27 5	128 2·5
Liu kiu Is.	Yori-sima, 413f.................	27 2	128 26·5
	Yerabu-sima, pk. 687f.	27 21·5	128 35
	Kakirouma I., 2207f., C. Ohotabu	27 38	128 55·5
	Sulphur I., Iwo-simas, 541f....	27 52	128 14
	— C. Sanafana	27 52·5	128 53
	Ioro sima, C. Kataki	28 00	129 9
	Amami oo Sima, Yiomi	28 17	129 19
	— Iono Misaki	28 31	129 42
	Kikai ga sima, pk. 864f.	28 17·5	129 59
	Sandon rks., 30f.	28 44·5	129 47
	Yoko sima, 1700f.	28 48	129 2
	JAPAN.		
	Tsus-sima, NS 7 l., The Sound	34 19	129 13
	„ South I., Ko-Saki Pt ...	34 5·5	129 12
	Colnett I., or Kotsu Sima, 800f.	34 15	130 6
	Iki I., NS 3 l., islet off N end	33 52	129 40
Goto I.	Goto Is., Uku sima. pk. 842f.	33 16·5	129 6·5
Goto I.	— Hira sima, pk. 663f.	33 1	129 14·5
Goto I.	— ⚓ 21 l., SW ext. Ose Saki, lt. R	32 37	128 36
Goto I.	Tama-no-Ura, ⊞, S pt entr.	32 41	128 37·5
Goto I.	Tori Sima, Pallas rks., S rk., 60f.	32 14·5	128 6·5
Goto I.	Me Sima grp., Uri Sima, (Asses' Ears), 607f.	32 1·5	128 23·5
	Hirado or Spex St., Taske lt.	33 23·5	129 33·5
	NANGASAKI, MINAGE PT.......	32 44·4	129 51·2
	Sagatsu no Ura, Kame-ura B., ⊞, entr..................	32 18	130 1
	Taka-sima or Symplegades, 210f.	31 27	129 43·5
	Tsukarase or Retribution rks., 96f.	31 18·5	129 44
Kiusiu Id.	Kami no Koshiki, pk. 1402f.	31 50	129 54
Kiusiu Id.	Shimo no Koshiki, S pt.	31 37	129 41
Kiusiu Id.	Kusakaki Sima High I., 530f.	30 51	129 26
Kiusiu Id.	Hasima Saki	31 45	130 11·5
Kiusiu Id.	Noma no hana	31 25	130 7
Kiusiu Id.	Okaimon Daki Pk., 3020f. ...	31 11	130 32
Kiusiu Id.	Kogosima, lt. F 45f.	31 35·5	130 33·7
Kiusiu Id.	C. Tschitschagoff, Satano Misaki, lt. F 200f.	30 59	130 39·5
Kiusiu Id.	C. Hisaki	31 16·5	131 7·5
Kiusiu Id.	O shima, lt Fl. 287f.	31 31	131 25
Kiusiu Id.	To Saki, 290f..................	31 47	131 29·5
Kiusiu Id.	Akatmidsu Hd.	32 29	131 46
Kiusiu Id.	E extr., Kiusiu, Sura Saki ...	32 55·7	132 6

MARITIME POSITIONS.

	(77) Places	Lat. N	Lon. E
Linschoten Is.	Kuro-sima, or Sta. Clara, 2028f. sum.	30° 50′	129° 56′
	Iwoga-sima, Volcano I., 2331f.	30 47·5	130 18
	Take-sima, Apollos I., 742f.	30 49	130 26
	Nagarobe or Julie, [1 l.], 2297f	30 27	130 13
	Yakuno-sima, $\frac{4}{4}$ 5 l., C. Yatake	30 27	130 30
	Tanega sima, NS 6 l., ⚓, N pt	30 50	131 4
	Disaster I., Fira Sima, 812f.	29 41	129 33
	Pinnacle I., Nuka Sima, 3400f	29 51·8	129 52
	Kuts-no-sima, 2230f.	30 0	129 56
	Suwa-sima, act. volcano, 2706f.	29 38	129 44
	Tokara Sima, Pennell, 860f.	29 7·5	129 14
	Sikok I., W. pt., or C. Misaki	33 20·5	132 1
	— S extr., or Isa-saki, 1500f.	32 44·2	133 1 7
	— C. Muroto-saki	33 14	134 11·5
	— Kamoda-saki, Sima	33 50·5	134 49·5
	Isumi Tomangai, lt. F	34 17	135 1
	Hiogo, (Kobé), Kawa-saki	34 40 5	135 11·2
	Akashi Palace	34 39·5	134 59·5
	Naruto passage, Nagasé	34 14	134 39 5
	Seto-Uchi, Sakaide	34 19	133 51
	— Imabari Palace	34 4	133 0
	— Matsuyama	33 51	132 45 5
Nipon, S. and E. Coasts	Nipon, S pt., Siwo Misaki I., lt. F 163f.	33 26	135 46
	C. Sima	34 17	136 54
	Omai-saki, lt Rev. 173f.	34 36·5	138 13 5
	Fusi-Yama, 12,450f.	35 20·7	138 44·2
	Iro-o-Saki, lt. F 185f.	34 36	138 50
	Vries I., [2250f. vol.], Hafu	34 40	139 27
	Isurugi Saki, lt. Fl.	35 8·5	139 40
	YEDO G., YOKOHAMA, Naval Store	35 26·4	139 39·2
	C. King, No-Sima lt. F 133f.	34 54	139 53
	Inuboye-saki, lt. Rev. 168f.	35 39	140 56
	Toyoma	36 58	141 1·5
	Kinkuwasan I., 1470f., lt. F 178f.	38 17	141 36
	Todo Saki	39 33	142 5
	Siriya Saki, lt. F 150f.	41 26	141 29
Is. S E. of Japan	Kosu-sima, volcano 2000f.	34 12	139 9
	Redfield rks., 20f., Southern	33 56·8	138 49·2
	Mikura I., [1 l.], mid.	33 52	139 34
	Broughton rks., 60f. (Kan-namba)	33 39	139 17·7
	Fatsizio, 2840f., S end	33 2	139 50
	Aoga-sima, 1000f.	32 29	139 43
	Bayonnaise Id., 26f.	31 55	139 54
	Smith I, 421f.	31 26	140 1
Nipon, W. Coast	Nipon, N pt., Omasaka-sima	41 34	140 55
	Tatsupi-saki, 362f.	41 16 3	140 21
	Bittern rks., 18f.	40 31	139 31
	Hatamura	40 2	139 46
	Tabu sima, E extr., 150f.	39 11·9	139 34·2
	Awa-sima, NE extr., 680f.	38 29·6	139 16
	Sado I, $\frac{4}{12}$ 13 l., N pt. Wasaki	38 19·9	138 31
	— South pt.	37 50	138 13
	Yutsis'ma, [2m.], ⚓, 40f.	37 49	136 55
	Astrolabe rk., Nana sima, 200f.	37 35	136 54
	Rokko saki, C. Noto, lt. F 152f.	37 31	137 18
	Ohama Harb., lt. F.	35 30	135 41
	Oki Is., $\frac{4}{4}$ 2015f., N pt.	36 21	133 18
	Mino Sima I., [1 l.], 492f.	34 47	131 6

	(78) Places	Lat. N	Lon. E
	Tsu no Sima, lt. Fl. 142f.	34° 21′	130° 51
	Simonoseki Strait, Shirasu, lt. Fr 44f.	33 59	130 47
	— Isaki, lt. F 122f.	33 57·6	131 1
Yezo I.	Yezo I., $\frac{4}{4}$ 95 l., S extr., or C. Sirakami, lt. R 120f.	41 24	140 13
	Ko-sima I., 1000f.	41 21	139 48
	O. Sima I., [2m], 2359f.	41 30	139 22
	Hakodate, Kamida Creek ... ⊕	41 47	140 43 7
	C. Yesan, 2063f.	41 47·5	141 11·5
	Volcano B, P. Endermo Hr.	42 19·9	140 59·5
	C. Yer mo, (rks. off), 3500f., lt.	41 55	143 16
	Akishi B.	43 2·4	144 51 7
	E. extr., C. Noyshap, lt. F.	43 25	145 46
	Skotan I., pk. 1400f.	43 45 5	146 36
	Kunashir I., $\frac{4}{4}$ 21 l., C. Moimoto	44 25	146 32
	C. Sirotoko	44 18	145 23
	N extr., C. Soya, Sonai, lt. Fl. 132f.	45 31	141 54
	Refunsiri I., C. Karanunai	45 17	140 59
	Tarari Is, Choresiri, 577f.	44 24	141 16
	Oterrani, lt. F 162f.	43 14	141 0·7
	C. Novosilzoo, lt. Fl. 248f.	43 19	140 22
	C. Sutsuki	42 37	139 51
	Okusiri I., Gomiga saki	42 15	139 33
	KOREA AND TARTARY.		
Korea, W. Coast	Low Barren Is., [1 l.], S one	39 12	124 34
	Pillar rk., 135f.	38 7	124 39
	Sir Jas. Hall's grp., Chong do. I.	37 46	124 44
	Seoul R., ent. Kuroda I.	37 30	126 3
	Clifford Is., W. I., 412f.	36 37	125 33
	Korean Archipelago, Guérin I., 582f. ○	36 7	126 0
	— Nan San Do, 579f.	35 21	126 2
	— Modeste I., 1191f.	34 42	125 14
	— Ross I., 1905f.	34 4	125 7
Is. off S. Coast Korea	Port Hamilton. Obs. spot ⊕	34 1·4	127 18·5
	Quelpart, $\frac{h}{6}$ 11 l., Beaufort I. off NE part	33 29·7	126 56·5
	Sentinel I., 340f.	34 33	128 42
	Sir H. Parkes Sd. Obs. I.	35 6·8	128 39·5
	Fusan Hr., lts. F	35 7	129 2
	C. Clonard	36 4	129 38
	Dagelet I., Matsu Sima, pk. 4000f.	37 31	130 52
	C. Duroch	38 46	128 16
	Port Lazaref	39 19	127 25
	Broughton B., isl. Hodo	39 41	127 45
Coast of Tartary	C. Bruat, 1542	40 51	129 40
	Tuman Ula R., entrance	42 17 6	130 42
	Expedition Bay, Tchurkhoda	42 37·9	130 48 7
	C. Gamova	42 33·4	131 14·7
	VLADIVOSTOCK, Scharnhorst's Station	43 6·8	131 52·7
	Askold I., lt. Fl. 590f.	42 43·8	132 21·7
	C. Krulov	42 40	133 4
	Siau wuhu Bay, S pt. Siaichu R.	42 54·2	133 50
	St. Vladimer Bay, Orekhova Pt.	43 53·7	135 27
	Suffren C., 1300f.	47 19	139 4
	Barracouta Hr, Tullo I.	49 1·8	140 19

MARITIME POSITIONS

	(79) Places	Lat. N	Lon. E
	C. Siourkum	50° 6'	140°43'
	Castries B., lt. F 262f.	51 25·5	140 55
	Amur R., Nikolaevsk Cathedral	53 8·1	140 43
Saghalin Island	Saghalin I, C. Jonquiere, lt. F 360f.	50 53	142 7
	Tcharaikove ossa Pt.	48 46	141 50
	Kosounai Road	47 58·7	142 13·7
	Monneron I., Totomosiri I., 1400f.	46 14	141 11
	C. Notoro, lt. F 135f.	45 54	142 2
	Kamen Opasnosti, 20f.	45 48	142 10
	Karsakovsk Road, lt. F.	46 40	142 44
	C. Siretoko	46 1	143 26
	C. Tonin	46 50	143 27
	Robben I., 48f.	48 32	144 45
	Tichmenev	49 13	143 9
	C. Patience	48 42	144 55·5
	C. Delisle de la Croyère	51 1	143 47
	C. Loevenstern	54 3	143 15
	C. Elizabeth	54 24	142 47
	C. Maria	54 17	142 18
	C. Golovatcheff	53 25	141 53
Okhotsk Sea	C. Khabaroff	53 30	141 3
	Reinecke I.	54 18	139 52
	Shantar Is., EW 20 l., E one, I. Procofieff, [4m.], E pt.	55 2	138 27
	R. Ouda, mouth	54 44	135 24
	St. Jonas I., [1m.], ✻₀, 1200f.	56 25	143 18
	Port Aian	56 25·5	138 21
	Okhotsk	59 22	143 14
	C. Bligan	58 40	151 37
	C. Piaghin	59 13	156 15
	Ghijinsk, lt. F.	61 53	160 37
	Penjinsk	62 30	162 56
Kuril Is.	Yetorup I., ⚓ 43 l., S pt., C. Rickard	44 25	146 56
	— N pt., C. Vries	45 40	148 45
	Urup I., ⚓ 17 l., SW pt.	45 37	149 32
	Pyramid rk., off N and E pt...	46 19	150 27
	Broughton I., [1 l.], *h*, ✻₀ ...	46 44	150 28
	Simusir I., ⚓ 10 l., S pt., or C. Rollin (Sianuni)	46 49	151 37
	Broughton B.	47 13	151 56
	Rashua I., [pk.], (rks. SW-d.)	47 51	152 47
	Matua I., Sarychev Pk.	48 6	153 12
	Raikoke I., [1 l.], sum.	48 16	153 15
	Musir Is., δ	48 35	153 44
	C. Ooeta, Shiashkotan I., ⚓ 4 l.	48 56	154 8
	Kharim-kotan I., [1 l.], pk.	49 11	154 35
	Onekotan I., ⚓ 2 l., S pt.	49 19	154 47
	Makanrushi I., [2 l.], mid.	49 51	154 32
	Paramushir I., ⚓ 20 l., S pt	50 1	155 23
	Shirinki I., [2 l.]	50 15	154 58
	Shumshu I., NS 3 l., mid.	50 46	156 26
	Alaid I., [2 l.], mid.	50 54	155 32
	KAMCHATKA.		
	C. Ongon	58 0	157 50
	Bolsheretsk, ent. R.	52 45	156 14
	C. Lopatka	50 53	156 46
	Mt. Vilutchin, 7060f.	52 42	158 22
	Avatcha B., ⊞, E entr., lt. F 526f.	52 52·5	158 47·0
	-- St. Peter and St. Paul, Ch.	53 1·0	158 43·5

	(80) Places	Lat. N	Lon. E
Kamchatka	C. Shipunski	53° 6'	160° 4'
	Kronotsky, pk., 10,610f.	54 47	160 37
	C. Kronotsky	54 54	162 35
	Kluchevski, volc., 16,131f.	56 8	160 48
	C. Kamchatka	56 0	163 15
	Behring I., ⚓ 16 l., NW pt.	55 17	165 42
	— South pt.	54 43	166 42
	Copper, or Medni I., S pt.	54 33	168 11
	C. Stolbovoi, *h*, ⊥	56 40	163 25
	C. Ozernoi	57 37	163 15
	Karaghinsky I., ⚓ 20 l., N pt.	59 13	164 38
	– South pt.	58 28	163 27
	C. Olutorsky	59 57	170 19
	C. Navarin, *h*	62 16	178 56
	NORTH-EAST COAST OF ASIA.		
Asia. E. Coast	Bay of Archangel Gabriel, NE pt., or C. King	62 28	179 14
	C. St. Thaddeus	62 42	179 30
	R. Anadyr, C. Alexandra	64 42	177 22
	Kresta Gulf, C. Meechken	65 29	181 15
	C. Behring	65 0	184 6
	C. Tchukotski	64 17	187 46
	Plover Hd.	64 21	186 40
	Arakam I., E pt.	64 46	187 54
	Metchignie B., entr., pt. *l.*	65 31	187 51
	C. Krléougoune	65 29	189 0
	St. Lawrence B., E pt. entr	65 37	189 11
	East Cape, SE extr., 2521f.	66 3	190 16
N. Coast	C. Serdze Kamen (Behring, 1728)	67 0	188 6
	Jinretlen (Nordenskiold, 1879-80)	67 7	186 26
	Burney, or Koliutchin I., S pt	67 27	185 55
	Herald I., 900f.	71 19	184 43
	Kellett land, or Wrangell I., C. Hawaii	70 58	182 20
	Mount Long, 2500f.	71 7	181 18
	C. North of Cook, 105f.	69 4	179 31
	C. Jakan	69 40	176 34
	C. Shelagskoi	70 2	171 10
	Bear Is, E or Column I.	70 38	162 20
	— West one	70 50	160 35
	De Long Is., Jeannette I.	76 45	159 0
	– Bennett I., C. Emma	76 40	149 0
	E Mouth of Indigirka R., pt...	71 0	151 40
	C. Sviatoi	72 52	141 0
	Lyakhow I., S pt.	73 10	143 15
	Liakhov Is., EW 70 l., New Siberia, C. Kamennoi	75 10	151 0
	— North I., Figurin	76 16	141 0
	C. Mufasch, mo. of the lana	71 35	135 0
	Lena R., mo., N, or lt ho. pt.	73 27	127 36
	Oleneka R, Dschanila I.	73 22	119 5
	C. Cheluiskin, N extr. of Asia	77 40	104 15
	C. Vega	77 36	103 20
	Einsamkeit I.	77 40	86 0
	Yenisei Gulf, E pt., Dixon Harbour	73 15	81 0
	Gulf of Obi, Drovianoi Pt.	72 43	73 18
	— White I., C. Schubert	73 7	72 5
	— Obdorsk	66 32	66 41

MARITIME POSITIONS

	(81) Places	Lat. N	Lon. E
	EASTERN ARCHIPELAGO.		
	Pontianak R., Pa djang I. ...	0° 2′	109° 10′
	Bangkai Pt.	0 19	108 56
	Set n ljang I.	0 21	108 45
	Buro g Is., Lamukutan, N pk.	0 48	108 42
	Sambas R., Fort Sorg	1 11	108 58
	Tanjong Api, *l*, ⚓, δ 2m., w′	1 57·5	109 19
	Tanjong Dato, *h*..	2 5	109 40·5
	Marundum I., small, 120f.......	2 3·5	109 6 5
	Tanjong Sipang, n rk. (rks. 5m.)	1 48	110 21
	Tajong Po, lt. F 490f.	1 44	110 32·5
	Sarawak R., New fort	1 33	110 21
	Sirik Pt., *l*, lt. F.....	2 46	111 21
	Mt. Silungun, 1500f.	3 48	113 47
	Tanjong Barram, *l*, rf. off ? ...	4 36	113 58
	Mt. Mulu, 8000f.	4 7	115 14
	Bruni, or Borneo, city palace	4 52·2	114 54·2
	Mi aro I., E pt.	5 0·4	115 4
	Labuan I, Ramsay Pt.	5 16·5	115 15
Borneo, N. W. Coast	Pulo Tega, δ, *N d* 3 l. N end	5 44	115 38·5
	Castle Pk., 1500f.	5 47	116 5
	Pulo Gaya, 6/5 4m., lt F	6 0	116 3
	Samarang Bk., 3½	5 36	114 53
	Vernon Bk., 2½ Fury rks.	5 44	115 2·5
	Saracen Bk., SW extr.	6 6	115 18
	Mangaloon I., small, δδ.........	6 11	115 35
	Amboug B., ẇ	6 18	116 19
	Kini Bam, Mtn., 13,700f.	6 7	116 33
	Matanani Is.. [5m.], W pt. ...	6 42	116 16
	N. Furious shl., 7	7 1	116 17
	N extr., Sampaumango Pt., Kalampunian I., off	7 4	116 43
	Balambangan I., 4/4 5 l., 2 ⚓ SE, 440f., Kalutan I....	7 13	116 49
	Banguey I., 4/4 7 l. NW, pk., 1876f.	7 17·5	117 5·7
	— E side, Bancowan I., S pk.	7 12·5	117 18·5
	Mang-i Is., 2/2 3 l., (rfs. WSW 3 l.). S′ I............	7 32	117 16
	— N one, Salingsingan I.	7 34	117 16
	Balabac I., NS 7 l., 1900f, S pt, or C. Melville	7 49	116 59
	Calandorang B., lt F 119f. ...	8 0	117 2·7
Palawan	Palawan, 4/4 80 l., S extr., or Pt. Bulilnyan	8 20	117 10
	Bulanhau hill, N end of range, 3,500f...............	8 40	117 24
	Albion head	9 17	117 58
	York breakers, [½m.], 1 foot	9 53	118 8
	Table Pt.	10 0	118 38
	Ulugan B., NW head............	10 8	118 45
	— Watering B.	10 10	118 48
	High I, off Port Barton, 1050f.	10 31	119 4
	Malampaya Sd., Pancoh	10 52	119 23
	Tapiutan I., (Rugg. Is.), N pt.	11 14	119 15
	Cabuli I., [1m.], 560f.	11 26	119 29
	Dumaran I., 6/5 5 l., E pt., Pirate Hd.	10 35	120 0
	Carlandagan I., NS 2m., E pt.	10 39	120 15
	Barbacan, Stockade	10 21	119 23
	Port Royalist, lt. F 43f..........	9 44	118 43
	Detached I., East I., [1m.], *l*	8 53	118 15
	Kanaron I., [½m.], 300f.	11 14	120 16

	(82) Places	Lat. N	Lon. E
	Nangaloo Is, [1 l.], NE pt....	11° 28′	120° 10′
	Yloe I., [3 l.]. S pt., rock off	11 16	119 42
	Linicapan, NW pt.	11 28	119 43
	Tres Reyes, rks., [½m.]	11 34	120 6
	Delian I., [1m.]	11 51	120 19
	Tara I., 2/2 3m., 730f., N pt....	12 20	221 21
	Busnanga I., 4/4 12 l., N pt. ...	12 20	119 53
	Colocoto rks., [1m.]	12 28	120 2
	Culion I., 2/2 7 l., Culion	11 54	120 0
	Philippine Islands.		
	Hunter Rock	12 41	120 11
	Merope shl., [2m.]...............	12 44	120 15
	Apo shl., 2/2 2 l.? Is. ⚓, Apo I.	12 40	120 24
	Falmouth Bank, NS 2 l., N pt.	11 54	120 58
	Panagatan shl.. EW 3m, 3f....	11 52	121 16
Mindoro Strait	Semirara Is.. N pt., [5m.], ⚓	12 7	121 20
	— S pt., or Pirate I., ‡ ′o, w, (a lake), SE pt.......	11 58	121 22
	Kiniluban, [1 l.], remkble. spire on W extr.	11 26	120 46
	Manignin I.	11 36 5	121 40
	Pontud bank	11 21	121 40
	Manamoc I. and rfs., [2 l.], pk.	11 18	120 42
	Cuyos I.		
	— Grt. or Cuyo I, Town... ⊖	10 51	121 1
	— E extr. or Taganayan ... ○	10 58	121 13
	— S extr., Imalagnan, 303f. ○	10 45	121 4·5
	— SW extr., islet, Paya, 90f. ○	10 48	120 36·5
	Sombrero rk., [10 yds.] ... ⊖	10 43	121 33
	White rk., 24f. .... ⊖	10 26	121 2
	Ambolon I., S end, (shls. SE d)	12 11	121 1
	Port Mangarin Town	12 21	121 5
	Pt. Lumintau .... ⊖	12 31	120 54
	Sablayan Pt.	12 50	120 45
	Mamburao R. .... ⊖	13 15	120 33·5
Mindoro	C. Calavite .... ⊖	13 26	120 17 5
	Paluan B.. vill., w	13 23·5	120 29·2
	Mt. Calavite, 2000f.	13 28·7	120 24
	Pt. Escarseo	13 31·6	120 59 2
	Silonay I.	13 27	121 13
	Pt. Dumali, (sum. 6/+ 3m.) ...	13 6	121 34
	Pt. Dayagan	12 38	121 32
	Pt. Pandan	12 17·5	121 23
	Libagao I., [2m.], 410f.	12 12	121 25
	Ilin I., Pt. Ilio	12 9	121 6
	Golo I., SE end	13 38·5	120 25·5
	Lubang I., 4/4 4 l., *h*, N pt ...	13 52	120 5·5
	— Looc Bay	13 43·8	120 16·7
	Cabras, or Goat I., lt. Fl.	13 54	120 2
	C. Santiago, (Minerva rk. ESE 5m.)	13 46	120 40
	Fortune I., [1m.], 450f.	14 4	120 29
	Friar, 120f. off Pt. Limbones	14 18	120 37 5
	Cavite, lt. F 30f..................	14 29·5	120 54·5
Luzon	MANILA CATHEDRAL............	14 35·5	120 58
	Orani	14 48	120 33
	Corregidor I., lt. Fl. 639f. ...	14 23 3	120 34
	Pt. Luzon, or Hornos	14 25·5	120 28
	Port Subec, Grande I.	14 47	120 13
	Pt. Capones, large I. off. *h*, ✱c	14 55·5	120 0 5
	Yba, town	15 20	119 58

MARITIME POSITIONS

	(83) Places	Lat. N	Lon. E
Luzon, W. Coast	Masinglnc, town	15°33	119°57'
	Hermana mayor I, summit	15 48	119 47·2
	Pt. Caiman, rf. SW	15 55	119 46
	Tambobo Pt.	16 0·5	119 43·5
	Bolinao, Tel. Station	16 24	119 56
	Port Sual, lt. F 79f.	16 6	120 7·5
	Dagupan R., lt. F 29f.	16 5	120 19·5
	Pt. San Fernando, lt. F 29f.	16 37·5	120 17·5
	Pt. Darigayos	16 51	120 20·0
	Port Santiago	17 18	120 27
	Pt. Dile	17 34	120 21
	Mt. Bulagao, 3629f.	17 38·5	120 31
	Pinget I., S pt.	17 40	120 22
	Culili Pt.	18 5	120 28·7
	C. Bojeador, *l*, β 2m.	18 30	120 34·5
	Pt. Mayraira	18 40	120 52
	Caraballo Hill	18 31·5	120 54
	Cabicungan Pt.	18 38·2	121 6
	Aparri, town, ‡' 10	18 21·3	121 37
	C. Engano, Hermanos Is.	18 35·5	122 6·5
Babuyan Is.	Dedicas rks., *h*, pkd.	19 3	122 9·5
	Guinapac rks., *h*, ⊤, ‖ W	18 58	122 4
	Camiguin I., ⅔ 4 l., (Port S Pio Quinto, ‡' W, w), volc., vis. 20 l., Font l.	18 55	121 48
	Fuga, or New Babuyan, EW 5 l, Port Musa, ‡, at W End	18 52	121 16
	Dalupiri, vis. 11 l., ‡₀, rks. S-d., N pt.	19 9	121 13
	Calayan, [3 l.], *h*, ⊤, rf., NW pt.	19 22	121 22
	Wyllie rks., 2, ⅔ 2m., N part	19 30	121 39
	Claro Babuyan, [5 l], *h*, volc. E end	19 31	122 1
Batan Is.	Balintang, or Richmond Is., 3, [1 l. ?], *h*, ⊥, ⊤, δ_0, N one, vis. 8 l.	20 1	122 18
	Sabtan I, NS 5m, S pt.	20 17	121 53
	Ibugos, NS 2m., S pt.	20 19	121 49
	Dequez, (Goat Is.), [¾m.], W. pt.	20 21	121 48
	Batan, or Monmouth, ⅔ 9m., r, w', N sum. 3806f.	20 28·5	120 1·2
	— San Domingo, Cathedral	20 27·5	121 59·0
	Diogo, (Grafton I.), [¾m.], 848f.	20 41·5	121 57
	Ibayat, (Orange I.), ⅔ 8m., r, ‡ W, N sum., or Sta. Rosa, 680f.	20 47·3	121 52·7
	Mabudis. ⅔ 1½m.	20 54	121 57
	Y'Ami, [¾m.], (North Islet is SSW 2m.)	21 5	121 58
Bashee Is.	Gadd's rk., or Cumbrian break	21 43	121 37·2
	Little Botel Tobago, [½m.]	21 57·7	121 36·5
	Botel Tobago, ⅘ 8m.? ✝, NE pk. 1850f.	22 5	121 33·5
	Vela Rete rks., [2m.], 25f.	21 45·1	120 8·2

	(84) Places	Lat. N	Lon. E
	Yligan Pt.	18°20'·5	122°18'
	Mt. Dos Cuernos, 4008f.	17 30	122 6
	Tumango Port, N pt. entr. ○	16 43	122 14
	C. St. Ildefonso ○	16 5	121 46
	Port Lampon	14 43	121 34
	Polillo I., 2½ 7 l., Banla Pt., (Is. SE-d.) ○	15 5	122 6
	— South point ○	14 43	122 4
Luzon, E. Coast	Jomalie I, [3 l.], E pt. ○	14 35	122 17
	Maulamat I. ○	14 30	122 19
	Cabelete I., [4m.], S pt. ○	14 15	121 50
	Alabat I, [3 l.], *l*, N pt ○	14 14	121 55
	Jesus Pt. ○	14 22	122 26
	Samur I. ○	14 31	122 43
	Matandumaten, *l*. Is. ○	14 17	123 5
	San Miguel B., Canton I., W of entr. [1m.] ○	14 4	123 5
	I. Batavanan, 2½ 3m., N pt.	14 9	123 17
	Sisiran Port, ⊞. Basi	13 55	123 36
	Palumbanes I., EW 3m., W pt.	14 5	124 4
	Catanduanes I., ⅔ 12 l., shl. N of, [1 l.], lot pt. ○	14 8	124 13
	— S or Taguntun Pt. ○	13 31	124 9
	Volcano of Isaro	13 39	123 21
	Volcano of Albay, 8274f.	13 16	123 41
	Rapurapu I., [3 l.], Unguy Pt.	13 11	124 10
	Pt. Montugan, rfs. 3m.	13 8·5	124 13·7
	Volcano of Bulusan	12 47	124 2
	St. Bernardino I., [2c.], ✳₀, ‖ E and W, 150f.	12 46	124 15
Luzon S. Coast	S extr. of Luzon, Calintan I.	12 31	124 5
	Los Naranjos Is., [2 l.], Raza I.	12 22	124 0
	Capul, 2½ 7m., N pt.	12 29	124 8
	Port Sorsogon, ⊞, town	13 0	123 59
	Ticao I., 2½ 5 l, N pt., S Miguel I.	12 43	123 36
	— Port San Jacinto, on E side, ⊞, w, r	12 32·3	123 45·5
	Masbate I., Bugui Pt.	12 36	123 15
	— Jintotolo I.	11 51	123 7·5
	— Port Barreras, on N side, ⊞, N pt. entr.	12 33	123 24
	Burias I., Busin lt F	13 8	122 58
	Cabeza de Bondo, 1250f.	13 12	122 35
	Marinduque I., 2½ 8 l., Marlanga Pt.	13 12	122 2
	— St. Andre, pt. 751f, ⊡	13 33	121 52
	Pagvilao I., ⅔ 1 l., S Pt.	13 53	121 45
	Pt. Locoloco	13 39	121 25
	Mt. Labo, sum. 3363f.	13 40	121 18
	I. Verde, ⅘ 5m., NE pt.	13 33·5	121 5
	Batangas, town, r	13 45	121 3
	Pt. Natoco	13 38	121 2
	Maricaban I., EW 2 l., rfs. E and W pts., W pt.	13 41	120 50·5
	Maestre de Campo I., [1 l.], Port Concepcion	12 54	121 44
	Dos Hermanas, Isabel I., 150	13 0	121 56·5
	Banton I., [1 l.], NE pt.	12 57	122 6
	Simara I., [2m.], N end	12 50	122 7
	Tablas I., NS ab. 12 L, Cabezo, 2405f.	12 38·5	122 10
	— P. Loog Town, ⊞	12 16	121 59
	Romblon I. Port, lt. F.	12 36	122 17

MARITIME POSITIONS

	(85) Places	Lat. N	Lon. E
	Sibuyan I., 6/16 5 l., pk 6424f., Pt. Cavit	12°16′	122°38′7
	Cresta del Gallo I., [1m.], S	12 11·5	122 42·5
Samar Strait	Samar I., 4/4 42 l., Batag I., NS 5m., N pt.	12 43	125 5
Samar Strait	— Port Palapa, Calapan I.	12 37	125 0
Samar Strait	— Borongon, town	11 42	125 25
Samar Strait	— S and E extr. l.	10 54	125 52
Samar Strait	— Manicani I., [1 l.], S pt.	10 58	125 38
Samar Strait	Canduay I., lt. F 33f.	11 26	124 53
Samar Strait	Parasan Pt.	11 44	124 46
Samar Strait	Sibugay I., N end, [1 l.]	12 0	124 27
Samar Strait	I. de la Mesa, [1 l.], Bagsipul I.	11 53·5	124 17·5
Samar Strait	Biliran, 6/16 7 l., Tincansan I.	11 41	124 20
Samar Strait	Carnasa I., small, S pt.	11 30	124 6
Samar Strait	I. del Gato, rk.	11 27	124 1
Samar Strait	Tagapula, 6/15 6m., E pt.	12 5	124 15
Leyte	Leyte I., 2/17 37 l., Gigantangan islet	11 35	124 16
Leyte	Port Palompon, town	11 2	124 24
Leyte	Camotes Is., NW one, Tulang	10 44	124 18
Leyte	Ylongos, town	10 23	124 44
Leyte	South pt., Leyte I.	10 0	125 2
Leyte	Limasana I., S end	9 54	125 4
Leyte	Panaon I., 2313f., S pt	9 55	125 16·5
Zebu	Bohul, EW 15 l., Namaunco Pt.	9 47	124 36
Zebu	— West point, or Pt. Duljo	9 ‹5	123 42
Zebu	Zebu, 2/12 35 l., Tañon Pt.	9 25	123 19
Zebu	— Zebu town, ⚓, fort, lt. F 42f.	10 17·5	123 54
Zebu	— NE, or Bulalaque Pt.	11 17	124 4
Zebu	Doon Is., SW I. ○	11 2	123 36
Zebu	Calangaman I., at E extr. of a rf.	11 7	124 15
Negros	Siquijor, 4/14 7 l., Pt. Minalutan	9 10	123 42
Negros	Negros I., 2/12 38 l., Siaton Pt.	9 2	122 59
Negros	— Pt. Sojoton, T	9 59	122 27
Negros	— North Pt., Ylacaon I.	11 2	123 11
Panay	Panay 4/14 32 l., S pt., *h*, ⊥, Juraojarao islet	10 24	121 57 5
Panay	S. Jose de Buenavista	10 44·5	121 55
Panay	Nalupapt rf.	11 13	121 59
Panay	Manignin	11 37	121 40
Panay	Pt. Pucio, 620f.	11 46	121 50
Panay	Borocay I., 436f., N pt.	11 59	121 54
Panay	Pontud, [1½m.]	11 50	122 15
Panay	Port Batan, ⚓	11 36	122 30
Panay	Olutaya Islet	11 38	122 50
Panay	Zapato Mayor	11 45·5	123 2
Panay	Jintotolo I., [1 l.], 120f.	11 50	123 8·5
Panay	Pt Bulacaue	11 37	123 9·5
Panay	Gigantes Is., [2 l.], Vaidajon	11 38	123 22
Panay	Culebra Islet	11 22	123 14
Panay	Baliguian Islet	11 12	123 20
Panay	Ilo Ilo Fort, lt. F 21f.	10 42	122 36
Surigao Is.	Suluan, [1 l.]	10 46	125 58
Surigao Is.	Malhon I., [4 l.], E pt	10 43	125 49
Surigao Is.	Dinagat I., Pt. Desolation	10 28	125 38
Surigao Is.	Gibnson I., N pt.	10 28	125 28
Surigao Is.	Siargao I., Sapao Pt., 620f.	10 4	126 3·5
Surigao Is.	P. Sibonga, entr., ⚓	9 41	126 1
	Bilaa Pt., N pt. Mindanao	9 49	125 26
	P. Surigao, ⚓, town	9 47	125 31·7

	(86) Places	Lat. N	Lon. E
Mindanao	Pt. Canit	9°17′5	126°14′
Mindanao	Catel, town ○	7 48	126 22
Mindanao	Pt. Pusan	7 14	126 25
Mindanao	C. St. Augustin, or Pandagitan ○	6 14	126 6
Mindanao	Palmas I ○	5 30	126 28
Mindanao	Davao R., lt. F 27f.	7 1	125 36
Mindanao	E Sirangani I., NS 4 l., w′, b, hill, S end	5 24	125 25
Mindanao	Pt. Tinaka, vis 12 l., T	5 35	125 16
Mindanao	Glan Masila R., lt. F 33f.	5 45	125 15
Mindanao	Volcano, 3600f.	5 45?	125 25
Mindanao	Leno Bay ○	6 45	124 00
Mindanao	Mindanao, R. entr. ○	7 16	124 11
Mindanao	Pollock Cove, ⚓, w, P, fort	7 21	124 11 5
Mindanao	Bongo I., 4/14 5m., SW pt.	7 18	123 59
Mindanao	Tiguma	7 46·5	123 25
Mindanao	Pt. Flecha	7 22	123 22
Mindanao	Oluntanga I., S pt.	7 16 7	122 48 5
Mindanao	Cocos I., small, 690f.	6 44	122 14
Mindanao	Sta Cruz Is., 2, E one	6 52 5	122 3 ?
Mindanao	Samboanga, w, r, Gov. Ho., lt. F 35f.	6 55	122 4·5
Mindanao	Caldera Port	6 57·5	121 57·5
Mindanao	Sibuco B.	7 20	122 4
Mindanao	Pt. Balangonan, ⟩—	7 47	122 5 5
Mindanao	Murcielagos I.	8 7·5	122 26
Mindanao	Pt. Sindangan	8 11	122 39
Mindanao	Pt. Blanca	8 32	123 4·5
Mindanao	Aliquay I., *l*, ✠, T S.	8 45	123 13
Mindanao	Silino I., *l*, ✠, T S.	8 51	123 24
Mindanao	Pt. Tabud, lt. F 43f.	8 42	123 22
Mindanao	Misamis town	8 9	123 47·5
Mindanao	Pt. Sulauang	8 38	124 29·5
Mindanao	Cagayan, anchorage	8 30	124 40
Mindanao	Pt. Bagacay	8 59	124 49
Mindanao	Camiguin I., [4 l.], 5338f.	9 11	124 44
	Sulu Sea.		
	Sultana Bank, 2/3	9 59	121 22
	Cagayanes Is., 5, *l*, ✠, (rf. N end)	9 47	121 20
	Calusa, [3c.], ‡o, ↑	9 36	121 6
	Anuling I.	9 44	121 25
	Cavelli I., 124f., [✠], NE extr.	9 14·2	120 52 ?
	— Reefs, SW extr.	9 10·5	120 45 7
	Jessie Beazley rf.	9 2 5	119 48
	Toob Bataha, shl., 4/14 7 l., rk. S extr.	8 49	119 55·5
	— Shl., SW-d, S rk.	8 43 5	119 51
Sulu Sea	St. Michael's I., Manuk Manukan, 32f.	7 42 6	118 28
Sulu Sea	— Bancawang, 123f.	7 44·8	118 33
Sulu Sea	— Bancoran, 140f.	7 56 6	118 41
Sulu Sea	Cugayan Sulu Is., 3, large one, *h*, ✠, rk. at entr. of circ. basin ⊕	6 59·1	118 29
Sulu Sea	— Keenapoussan I.	7 11·3	118 26
Sulu Sea	— S extr., Mulegee Is., T, δo	6 53	118 24 ?
Sulu Sea	Mambahenauan	6 34	118 31·5
	Talantam bk., 5	5 42	119 27
	Pearl Bank, ent.	5 48	119 39
	Tawi Tawi, Bongola, ‡	5 3	119 47·5
	Manuc Manca, S pt.	4 47 2	119 50·5

MARITIME POSITIONS

(87) Places	Lat.	Lon. E
Sulu Archipelago	North	
Sibutu I., N pt.	4° 54'8	119° 27'
Doc-Can, W pt.	5 52·5	119 56
Cap, N end	5 59	120 10
Pangootaran Is., Ubian I., 72f., S pt.	6 7·7	120 27·5
Kulassien, rfs., E pt.	6 26	120 43
Salleolookit Is.	6 41	121 22
Griffin rks.	6 46	121 24
N extr, Teyngu I., small, *l*, ✝	6 53	121 37
Sangboys Is., small, S end	6 50	121 36
Basilan I., EW 11 l., 3970f., P, Pt. Matanal	6 38	122 19
— Pasanhan, ⊞, ẁ, Isabela fort	6 42	121 57·5
Cocos I., 690f.	6 44	122 15
Sibago, *h*, E islet, 935f.	6 44	122 23
Bubuan, E pt., 794f.	6 21	121 57
Tapeantana, small, pk., 938f.	6 18	121 57
Bulan, EW 4 l., *l*, w, E pt.	6 8	121 52
Simisa, N pt.	5 59	121 35
Sulu, EW 12 l., w, r, b, Port, lt. F 35f.	6 3·2	120 59·5
Suladde I., E pt.	5 50	120 48
Pata Pk., 1434f.	5 49	121 9
Kabingan Is., 2, *l*, ✝, Boaeon	5 43	121 0
Siassi Pk., 1714f.	5 32	120 52
Simaluc Pk., 127f.	5 25·7	120 15
Sigboye passage, Dangerous Pt.	5 13	120 43
Borneo.		
Borneo, N.E. Coast		
Banguey, NW pk., 1876f.	7 17·5	117 5·7
Bancawan I., S pk. ○	7 12·5	117 18·5
Mallawallee I., NW pk., 582f.	7 3·5	117 17·2
Pt. Sugut	6 26·5	117 43·5
Lankayan I., ✝, 100f. ○	6 30	117 55·5
Libarran I, 140f.	6 7	118 1·5
Bagnan I., 228f.	6 6	118 27
Sandakan B., 3 ⊞, w', h, Bahala I., pk., 643f.	5 52	118 9
Kinabatangan R., Driftwood Pt	5 38·5	118 38
Usang Pt., Hull Rock ⊕	5 17	119 17·2
Borneo, E. Coast		
Darvel, B. Silam	5 0	118 10
Si Amcel I., 800f.	4 20	118 53
Sipadan I., 120f.	4 7	118 36
Ligitan, grp., Mabul I, 120f.	4 15	118 36
Sombakong, (mouth of R.)	3 44	117 50
Sesajab R., Tibu Pt.	3 26	117 42
Bulungan, town	2 51	117 21
Maratua I., NS 5m., N pt.	2 18	118 34
Pantai R., mouth	2 2	117 53·5
Mauras rf., Sambit I., [8 l.], rfs.	1 47	119 6
Mangka Liat Pt.	1 1	119 1·5
Krindingan I.	0 5	117 37
	South	
Mabakkan R., Bayor Pt.	0 43	117 38
Balik Pappan B., N entr. pt.	1 15	116 50
Passier R., entr., Muara	1 52	116 24
Aru Pt., ⊥, ✝, (shls. 3 l.) ○	2 10	116 36
Pamukan B., Mirra Pt., *l*, ✝, (riv. S) ○	2 33	116 31
Pulo Laut, NS 18 l., P, Pemantjing Pt. ⊖	3 12	116 16
Brothers I.	4 26	116 10·5
Sembargelap Is., Marabi I.	3 39	116 36
St. George shl., [¼m.], 4	4 12	116 14·5
Moresses, Siri Is., 8 3m., pk.	4 22·5	115 48

(88) Places	Lat.	Lon. E
Borneo, S. and W. Coasts	South	
Dunalder I., *l*, ✝, …	4° 14'	116° 7'
S. pt. Borneo, Tanjong Salatan	4 10	114 40
Baruto R., Burung Pt.	3 34	114 30
Tanjong Malatayo	3 38	113 35
Sampit B., Bandaran Pt.	3 16	113 8
Flat Hook, or C. Puding	3 33·5	111 50
Kotarvaringin B., Samadra I.	2 54	111 24
Tanjong Sambar	3 0	110 18
Fox's shl., 2	3 30	110 10
Clemencia Reef, β	3 22	110 8
Rendezvous, or Kumpul, 4 4 l., w' W. SW pt.	2 45	110 3
Minto hill, 328f.	2 15	110 4
Succadana, town ○	1 14	109 58
Mt. Maja, 1733f.	1 7	109 29
Padang Tikar Pt.	0 40	109 16
Strait of Macassar.		
Strait of Macassar		
Laurot, or Little Pulo Laut Is., [10 l.], Sand W extr.	4 49	115 45
Sibbald's bks., western ○	5 46	117 4
Komba I., (shl. S end)	5 15	117 4
Siri, 4 Is., vis. 7 l., ✝, Sibaru	5 5	117 3
Laurel shl.	4 30·5	117 6
Gt. Doangdoangan	5 23	117 55
Kalu Kalukoan Is., Rotterdam	5 16	117 36
Medenblik, or Edam	5 3	117 55
Laars bk., Dewakan I., (shl. 12 l., S.d)	5 24	118 26
Tonyn I.	5 29	118 39
Lanjuákan Is., Lankai	5 1	119 5
Teignmouth shl., W. limit	4 55	118 39
North Watcher	4 33	119 14
Kapo Posang	4 42	118 58
Dry sand bk.	3 31	117 28
Triangles, 3, [1 l.], S one, ✝ ○	3 5	117 51
Hannah shl., centre ○	2 20	117 3
Little Paternosters, 13 Is. and bks., *l*, ✝, (S lim. uncert.; bks. NW 3 l.), NW Id., w, Teleensing	2 15	117 8
— East I., w, Balabalágan	2 33	117 58
Celebes.		
Layken Pt.	5 37	119 30
Tana-keke I., [4m.], ✝, N pt.	5 27	119 18
Sammalóna	5 7	119 20
Macassar, Rotterdam fort, N bast., lt. F	5 8·2	119 23·2
Pt. Lero	4 3	119 35·5
C. Mandar, *h*, T	3 35	118 57
C. Kait	2 51	118 47
C. William, *h*, (an Id. off) ○	2 37	118 50
Palos B., ⊞, town	0 55·5	119 51
— Dangola	0 39·5	119 44
	North	
C. Temul, rf., W 5m., N pt.	0 4	119 43
South Watcher	0 7	119 39
C. Dondo, (rf. NE 10m.), *h*, T ⊖	0 58	120 17

MARITIME POSITIONS

	(89) Places	Lat.	Lon. E
Celebes. N. Coast	C. Rivers, vis. 30 l., Slime islets, 80f., ⚓, ↜	North 1°20′4	120° 44′5
	Penjang I.	1 19	121 3
	C. Kandie, or Dako	1 20	121 25
	Josina rfs., Bongkie I.	1 5	122 57
	Mt. Soputan, 5994f.	1 7	124 45
	Manado, Fort Amsterdam	1 30	124 46·5
	Mt. Klobat, 6694f.	1 28	125 2
	Toua Manado I., [3m.], 2737f.	1 39	124 42
	— Naiu I., [1½m.], 765f.	1 47	124 47
	Talisse I., ⚓ 6m., 1168f., N pt.	1 54	125 6
	Banka, ⚓ 7m, E pt	1 48	125 11
	C. Coffin	1 41	125 10
	Limbe I., ⚓ 3 l. N pt.	1 33	125 17
	Kema, w, r, fort	1 22	125 5
	Belang Town	0 56	124 47
	C. Flesko, Kalapa I.	0 26	124 27
	Gorontalo R., r, w, lt. F 95f.	0 30	122 58
		South	
	Parigie	0 47	120 9
	C. Tellogonda	0 58	120 34
	Una Una I., N pt.	0 9	121 35
	C. Apie ○	0 47	121 36
	Grt. Waleah I., N end	0 13	122 12
Celebes, E. Coast	C. Talabo, h, E pt ○	0 46	123 27
	Toko B., Onee Malubu Pt. ○	1 58	121 33
	Peling I., E pt. ○	1 17	123 31
	Bangkulu I., S end ○	1 57	123 5
	Nederburgh Pt., δ 5m.	2 53	122 17
	Low Ambeli I.	3 6	122 33
	Labengki I., [5m.], E pt	3 27	122 28
	Manni I., [3 l.], h, NE pt.	3 35	123 12
	Pt. Nipa Nipa, N extr.	3 54	122 39
	Kendarie B., Wowebalu Pt.	4 0	122 38
	Wawoni I., [5 l.], E pt.	4 5	123 11
	Bouton I., ⚓ 27, l., N pt.	4 23	123 4
	— East pt., l	5 13	123 15
	— South pt.	5 42	122 48
	— Bouton town, fort, r, P.	5 28	122 37
	South I., S pt.	5 43	122 30
Celebes, Gulf of Boni	Kabaena I., [5 l.], pk. 4000f.	5 19	121 55
	Mengkoka B., Tahoa	4 3	121 40
	Berayu	2 40	120 42
	Palopa B.	2 55	120 13
	C. Djenee	3 18	120 29
	C. Patiro	4 38	120 27
	Boni, city, 5m. inland	4 32	120 18 5
	Salengketa Pt.	4 50	120 22
	Boni rk.	5 15	120 32
	C. Lassa, or Biera	5 35	120 28
	Sarontang	5 39	120 30
	Salayer I., ⚓ 13 l., N pt.	5 45	120 29
	Whale rf., 2	6 7	120 19
	Bulekombo, ww₀, fl. st	5 31·5	120 12
	Mansfield shl., 4, Bolloh	5 45	120 12
	Mt. Lampo Batang	5 21	119 56
	C. Bulu Bulu	5 42	119 45
	Java.		
	Button, Toppers I.	5 54·2	105 55·8
	Pulo Babi, EW 3m., W pt.	5 48 7	106 15
	Bantam, fl. st	6 1·7	106 8·7
	Mt. Karang, 5833f.	6 14·5	106 0·7
	Pontang Pt.	5 56·3	106 16

	(90) Places	Lat. S	Lon. E
	Hoorn Is., EW 4m., rk. W-d., Payung Dekat	5°47′7	106°28′
	BATAVIA, OBSERVATORY ♦ 0ʰ, G.M.T. 7ʰ 7ᵐ 14·5ˢ	6 7 6	106 48·5
	— Edam I., lt. F 182f.	5 57·5	106 50 5
	Karawang Pt., ⚓	5 56·3	107 0·2
	Tanj. Sedari, ⚓ NW lim.	5 58 5	107 21
	Sedari rf., [3m.], 3, ǁ S	5 56	107 25
	Pamanukan Pt.	6 12	107 46
	Indaramayu Pt., ⚓, ⚓, E extr.	6 14	108 18
	Boompjes Is., lt. R 191f.	5 56	108 22·5
	Cheribon, lt. F 46f.	6 43	108 34 2
	— Pk., 10,075f.	6 54	108 24 2
	Tegal, lt. F 48f.	6 51	109 8
	Pekalongan, lt. F 50f.	6 51·5	109 41·2
	Mt. Selamat, (vol.), 11,224f.	7 14·5	109 13
	Bapang shl., [2m.], 3	6 34·5	109 50
	Mt. Sumbing, 10,945f.	7 23	110 4
	Samarang, lt. Fl. 107f.	6 57	110 24 5
Java N. Coast	Japara, Po. Panjang	6 34 6	110 37
	Mandalika I., lt. F. 280f.	6 23	110 54 7
	Laut, Juana, lt. F 49f.	6 41 5	111 9
	Leran Pt.	6 38	111 27 5
	Aur Aur Pt.	6 46	111 56·7
	Panka Pt., l, fl. st	6 53	112 34
	Sourabaya, citadel, lt. F 42f.	7 13 5	112 44
	Madura, EW 29 l., NW pt., C. Modung	6 54·3	112 49
	— East pt., Lapa Pt.	6 58 5	114 7
	— Sumenep B., fort	7 2	113 54
	Pajangan I., [1m.]	6 58	114 20
	Hog I., or Sapudi, ⚓ 9m., W pt., lt. F 192f.	7 5·3	114 16
	Po. Kamudi	7 6	114 47 7
Java E. Coast	Pasuruan, lt. F 52f.	7 37 5	112 55
	Besuki, lt. F 39f.	7 43 5	113 41 2
	Pt. China	7 35	114 2 2
	C. Sedano	7 49	114 28
	Karang Maas, Meinders rk., lt. F 56f.	7 0·5	114 26
	Mt. Merapi	8 3 7	114 15·5
	BANJUWANGIE, FT. UTRECHT lt. F	8 12 8	114 23
	Tanj. Soloka, E pt. of Java	8 42·5	114 36
	South pt. of Java, Ba nenan	8 46·7	114 31·5
	Nusa Barung I., EW 9m., ⊥, ⚓, Kamal Pt.	8 27·5	113 25·2
	Semiru, Mt., 12,140f.	8 6 5	112 55·2
	Arjuno, Mt., 10,320f.	7 45 7	112 35 5
Java S. Coast	Sempo I., EW 5m., S pt.	8 27	112 42 5
	Segoro Wedi B., Klappa I.	8 22	111 43·5
	Skel rk.	8 24	111 42 5
	Pachitan B., E pt., entr.	8 15	111 5
	Kembangan I., ⚓ 14m., inlet of Tylatiap, lt. R 655f.	7 46 6	109 2
	C. Sanchang	7 44	107 50
	C. Genteng	7 23	106 24
	Zand Bay, ⚓ 12, Panchur Pt.	7 11	106 24
	Po. Tinjil, or Trouwers I., ⚓ 4m., W pt.	6 58·3	105 46·2
	Kelapa, or Breakers I., EW 3m., rks. W pt.	7 0	105 33
	C. Sangian Sira, (rks. SE), T, 1575f. sum.	6 49	105 16
	Java Hd., First pt., lt. Fl. 260f.	6 45·3	105 12·7

MARITIME POSITIONS

Region	(91) Places	Lat. S	Lon. E
	Java Sea to Flores Sea.		
Is. and Shoals in the Java Sea	Woerden Castle, rk., or Pamanukan, (shl. 2 $\frac{2}{7}$ 3m.)	6° 1·5'	107°52·5'
	Pulo Rackit, Boompjes, [1½m.], lt. R 91f	5 56	108 22·5
	Karimun, Java Is., EW 13 l., ⚓, b, W extr., or Katang rk.	5 48·3	110 8
	— Karimun I., $\frac{6}{5}$ 5m., SW pt., fl. st.	5 53·5	110 26·2
	Hastings rk., 2	6 5·5	112 30
	Bavean I., $\frac{4}{4}$ 12m., 2000f., w, r, N pt., Maotegi	5 43	112 41
	— Sankapura Bay	5 51·5	112 39
	Arrogant rk., [¼m.], T	5 12	112 57
	Grt. Solombo, $\frac{2}{12}$ 6m., ✱, flat hill, 620f.	5 33	114 27
	Little Solombo, [3m.], *l*, ✱ 118f.	5 27	114 26
	Arends, [3m.], N end	5 2	114 33·5
	Karaog Takat grp., $\frac{6}{5}$ 4 l., rks., W pt.	7 0	114 55
	Kangeang, $\frac{6}{5}$ 9 l., Ketapaog B.	6 50	115 17
	Paudjaog. EW 3 l., E pt., (rks. off)	7 10	115 55·5
	Urk, [2m.], *l*, ✱, Id.	7 4·6	115 11·5
	P. Maurit's rf.	6 19	115 29
	Belliqueux rf. 4	6 31	116 0
	Turkey, Polo or Anak Kangeang Is., and shls., N I., Ara han	6 31	115 44
	Sakala or Hastings I., *l*	6 57	116 15
	Paternoster Is., Pulo Tengah, NW, Paposa, (rks. 2 l.)	7 30	117 10·5
	NE Paternoster Bankawang	6 38	118 21
	Postilion Is., $\frac{4}{4}$ 12 l., *l*, ✱, T, N island, Jailamu	6 33	118 47
	— E. I., Pumau Tawan	6 50	119 11
	— Lamaroa I., small	7 18·5	118 6
	Brill shl., Taka Reuataya, [4m.], T, *B*, lt. F, Fl. 68f.	6 7	118 57·5
Is. and Shoals Southward of Celebes	Mamalaki I., small, rfs., ‖ E.	6 43	120 19
	Rusah I., $\frac{2}{7}$ 2 l., S pt.	6 44	120 26
	Vesuvius rk.	7 6	120 24
	Jampea I., $\frac{6}{5}$ 5 l. (Kambaragi B., SE side, ⚓', w'), S pt.	7 7	120 39
	Kalao I., EW 6 l., rks., W-d. 2 l., P,,, SW pt. I.	7 18	120 52
	Bonerato I., $\frac{4}{4}$ 4m., (‖ W, δ_0), Bonerato	7 20	121 5
	Marianne shoal (1820), [2 l.], SW I ○	7 29	121 10
	Kalao Toa I., Cornelia Rd.	7 25	121 48
	Madu I., $\frac{6}{5}$ 2 l., W pt. rts., T	7 31	121 43
	Kabia, or Perch I.	6 54	122 12
	Post-horse Id. (Kauna)	7 27	122 1
	Angelica rf., [4m.], centre	7 47	122 16
	Rusa Rajah, ✱, ‖ S, 4593f., pk.	8 17	121 44
	Rusa Linguete, 1902f., (rf. 2m.), pk.	8 5	122 6
	Hegadis Pk.	6 7	122 40
	Token Besi Is., S lim., Binongka, S pt.	6 2	124 5

Region	(92) Places	Lat. S	Lon. E
	Token Besi Is., Kaka Rf., South rk	6° 7'	124°16'
	— N limit, Wangy Wangy, vis. 7 l., sum.	5 18	123 35
	— St. Matthew's Is., $\frac{4}{4}$ 5 l., ‖₀ SE pt.	5 27	124 21
	Veldthoen I., [5m.], *l*, ✱, Moro Maho, centre	6 7	124 37
	Bali to Flores.		
Bali	Bali, $\frac{6}{5}$ 33 l., *h*, Mt. Agung, 10,500f.	8 21	115 31
	Badong B., Bukit pt.	8 49	115 5
	Beliling, lt. F 58f.	8 6	115 5
	C. Pasir	8 6·5	114 25·5
Lombok	Lombok, $\frac{4}{4}$ 23 l., Mt. Rinjani, 11,810f.	8 25	116 27
	— Labuan-Tering B.	8 44	116 3
	— Pandaman pt. (C. Baoko)	8 44	115 49
Sumbawa	Sumbawa, EW 51 l., SW pt., Tafelberg	9 0·5	116 44
	— Sumbawa, town	8 28	117 24
	Flat I., Ma lang [1 l.], E end	8 8	117 25
	Gulf of Saleh, Rakit I., pk.	8 38	117 58
	Setonda I., W pk.	8 6	117 44
	Mt. Tambora, 9070f., volcano	8 14	117 58
	Jorn Batu Pt.	8 14	118 29
	Bima Bay, ⊞. fort	8 27	118 43
	Sangeang I., 6180f., pk.	8 11	119 4·5
	Sapeh Pt.	8 45	119 8
	Gili Banta I., [2 l.], T, pk.	8 25	119 16
	Leeuwenkop pt.	8 51	118 51
	Komodo, or Mangarei, NS 7 l., *h*, ⊥, Schoorsteen	8 45	119 22
	Flores, Timor, and Sumba Islands.		
Flores	Flores, EW 67 l., Alligator B.	8 48	119 50
	Teraog and Bari Bays, Bari	8 20	120 11
	Potta Rd., Potta	8 18	120 42
	Giliting	8 35	122 16
	Tower I., EW 1 l., 1200f.	8 53	120 14
	Ende B., ⚓, Aloso Pt	8 52	121 39
	Lobetobie, volcano, 7120f.	8 35	122 48
	Flores Head, or Iron Cape	8 3	122 47
	Larantuka Road	8 18	123 1
	Kambing, S entr. Flores Strt.	8 39	122 51
	Adonara, $\frac{6}{6}$ 12 l., town	8 14	123 9
	Solor, $\frac{4}{4}$ 9 l., S pt., islets off	8 30	122 52
	Komba I., vol., 1800f.	7 47	123 31
	Lomblen, $\frac{4}{4}$ 12 l., E pt.	8 14	123 54
	— Mt. Lamararap, 5880f.	8 31	123 25
	Pantar, $\frac{2}{7}$ Babi I., off SW pt	8 25	123 52
	— North East pt.	8 10	124 14
	Ombay, EW 17 l., Dalolo	8 12	124 23
	— East pt., Leisumbu	8 18	125 10
Timor	Timor, $\frac{6}{6}$ 85 l., SW or Oysina Pt.	10 23	123 29
	Koepang, ft. Concordia, lt. F 47f	10 9·9	123 35
	Wedg. Pt.	9 33	123 40
	Sutranha, ⚓ 18	9 20	124 5
	Gula I., small	9 14	124 0
	Lifou, r, w	9 10	124 25
	Atapopa, lt.	8 59	124 50

MARITIME POSITIONS

(93)	Places	Lat. S	Lon. E
Timor	Dilhi, town, r, Custom ho , lt. F	8°33′	125°36′?2
	E pt., ‡′ 16, Po. Jackee, or Nusa Bessie, sum. 350f. ...	8 26	127 20
	Kalaeko, town	9 6	126 12
	Noy Mini B , ‡	10 5	124 18
	Semao, 6/6 5 l , S pt.	10 22	123 25
	Rotti, 6/6 14 l., vis. 12 l., Cyrus B. on SE side, w, r	10 52	123 5
	— Pulo Dana, off S pt	10 58	122 55
	Pulo Dau, 6/16 4m., *l*, ⚓, N end	10 48	122 41
Sumba	Savu, EW 7 l., W C. Mesara...	10 34	121 41
	— East pt., *l*, (rks. off)	10 27	122 0
	Banjoan, EW 7m., SW pt., *l*.	10 37	121 31
	Dana, or New I, [1 l.], S part, 120f.	10 49	121 16
	Sumba or Sandalwood I., 6/16 24 l., C. Lambuya, (rks.)	9 42	119 0
	Palmedo Road	9 25	119 45
	Paddeway B., ⊞, [5m] 16, r, δ_o, Arit town anchge.	9 37	120 12
	E point. C. Mandyeli	10 12	120 51
	C. Blackwood	10 23	120 29·7
	Banda Sea.		
	Cambing, or Passage I., 2/2 4 l., *h*. S pk , 3273f.	8 18	125 35
	Babi I., sum. ....○	8 2	125 45
	Wetta, 6/5 19 l., Sau town, on SE side, ‡	7 53	126 24
	Gunong Api, volc.. 1378f.......	6 39	126 36
	Lucipara, 5 Is., N ld.	5 28	127 29
	Kissa l., 803f., Pura landing	8 6·7	127 8·5
	Roma. [3 l.], *h*, Uwakekee ..	7 42	127 20
	Letti I., Serwaru, Church ...	8 10·2	127 40·5
Serwatty Is.	Moa, 6/16 6 l., ‡ E, Buffalo Pk., 4100f.	8 12	128 2
	Lakor, [3 l.], *l*, E end	8 14	128 13
	Luang, [1 l.]. *h*, 1″ ....○	8 12	128 39
	Sermatan, [5 l.], W pt., Eto ○	8 11	128 48
	Damma Is., NS 5l., 8117f. Kulewatte Harbour	7 9	128 40
	Tau, [3 l.]. 2000f., ‖o Lajani ○	7 2	129 7
	Nila, [3 l.], 3898f. sum.........	6 52	129 28
	Serua, 2 Is., [3 l.], W. l.	6 17	130 0
	Bird l., or Po. Mano, 880f. ...	5 33	130 18
	Wetan, ‡ E, 1160f.	7 50	129 33
	Baba, w, P,, S pt. 3000f.	8 2	129 45
	Masella, S pt. 839f.	8 11	129 51 5
Tenimber Is.	Tenimber Is.,‖o; Timor Laut, 2/2 34 l , S end, Jermata	8 0	131 14
	Selaru, Woody l., small	8 22	130 48
	Oliliet, village, 413f.	7 55	131 27
	Larat, 6/16 6 l., Lamdesar	7 17	131 58
	Vordate, 2/2 2 l., ⚓, Sobiani...	6 58	131 55
	Sera l., Aba	7 44	130 56
	Mulu I , Nuskalbur	6 38	131 37
Arru Is.	Arru Is., NS 35 l., *l*, ⚓, r, P,, S extr., Ennu I., 100f.	7 6	134 31
	— SW limit, Bayn	6 48	134 7
	— Po. Babi, small............	5 55	134 9
	— NW extr., Wassir...........	5 32	134 13
	— C. Watale Juhong	5 17	134 32
	— Dobbo Harb., ⊞, pt........	5 45	134 14
	Tjando Is.. N lim. ....○	5 20	132 33

(94)	Places	Lat. S	Lon. E
Ki Is.	Grt. Ki I., 2/2 15 l., ⚓, 3000f., C. Borang	5°17′	133° 9′
	— Nuja	5 42	132 57
	— Madua Pt.....................	6 3	132 53
	Little Ki l., Rumadan I.	5 28	132 42
	— Ki Doulan, vill., ⊤, w, r, b, (‡′ 3m. N), pi r ...	5 34·7	132 45·?2
	Nusa Tello Is., Fadd I. ......○	5 40	131 58
	— Koor I., S pt. ....○	5 25	132 0
	Uran I.	4 46	131 52
	Kelmui I., S pt.	4 47	131 44
Banda Is.	Matabella Is., 2 groups, ‖, grt., Kasiwooi, S pt.	4 31	131 38
	Manovolko l., Sera..............	4 9	131 23
	Suruaki-Wiseleat ....○	4 1	131 14
	Goram I., [3 l.]. NE pt.	3 59	131 26
	Banda Is , 5, W, or Po. Rhun	4 33	129 38
	— NW one, or Swanji	4 18	129 40
	— Banda, 6/6 6m., Fort Nassau	4 32	129 53
	— East one, Rozengain......○	4 36	130 2
Bouro	Bouro I., 6/6 27 l., Palpatu Pt , ⊤	3 6	126 1
	— Mt. Tumahu, 8530f..........	3 15	126 2
	Cajeli B., r, w′, b, Fort Defence	3 22·8	127 6·5
	East point, or Pt. Fela	3 21	127 16
	South pt , or Baton P kka ...	3 54	126 37
	Amblaw I., [2 l.]. NE pt. ...	3 52	127 17
	Manipa l., *h*, (rk. 1½m. W), E pt., Lubu..................	3 20·5	127 40
	Kelang, *h*, ‖ W, W pt.	3 12	127 38
	Boano, *h*, ⊥, SW pt....	3 1	127 51
Ceram	Ceram, 6/6 59 l., Pt. Secal......	3 33	127 55
	— Sawaai Harb.................	2 57	129 12
	Wahaay Harb., vill., w‴, r, b, fort	2 48	129 29
	Pasahafi Pt.	2 52	129 42
	Lama Pt.	3 0	130 24
	Leuwarden shl., [2m.], ⊤, rks.	2 55	130 33
	Waru B., ‡′, w, r, Baru	3 22	130 35
	Po. Parang, or Leuwarden I , S pt.	3 21	130 48
	Po. Madurang, small	3 37	130 59
	Great Kefing l., E pt. ......○	3 51	130 47
	Ceram Laut, Gesser I. ......○	3 3	130 52
	— Kon ....○	3 57	131 12
	Amboina I., 4/4 11 l., SW, or Alang Pt., ⊤	3 47	127 57
	Amboina City, Fort Victoria...	3 41·2	128 10·2
	Noessaniva Pt., ⊤	3 46	128 6
	Haruku I , 4/4 8m., SW pt. Islet	3 38	128 26
	Saparua I., 4/4 11m., fort	3 4·5	128 38
	Nusa Laut, 6/6 7m., Nalahia B.	3 38	128 46
Sula Is.	Bowakan..........................	1 54	123 45
	Hammond's I., [3 l.], S pt. ...	1 52	124 1
	Taliabu, EW 18 l., Lekitobi...	1 57	124 27
	Mangola, 16 l., EW ‖o, Lisamatula I., 1164f............	1 50	126 25
	Vesuvius B., ‡	1 58	125 30
	Sula Besi, NS 10 I., S and E pt., Ipa....................	2 24	126 6

MARITIME POSITIONS

(95)	Places	Lat.	Lon. E
		South	
Pitt Passage	Oby Latta, [2 l.], S pt., 2400f.	1°29′	127°16′
	Gomomo, 850f., W pt.	1 52	127 33
	Po. Gasé, [5m.], T, rks. SE, S pt.	1 39	128 22
	Tapa I., NW pt.	1 12	127 17
	Bisa, E pt.	1 16	127 37
	Oby Major, 6/5 19 l., SE pt , Wai	1 44	128 0
	Lookisong I., 2/2 3 l., ⚓, N pt.	1 32	128 8
	Kekik I., *h*	1 30	128 37
	Lawin I., *h*	1 29	128 42
	Po. Pisang, vis. 11 l.	1 24	128 53
	Grosvenor shl , [4m], 5f	1 19	129 26
	Bu Is., ⚓, P. Esplee ○	1 10	129 25
	Grand Canary, w, E pt., NW pt.	1 45	129 37
	Mysole, EW 14 l., Lungu	1 53	129 42
	Hasil I., S pt.	1 11	128 28
	Gilolo.		
Gilolo Passage	Gilolo, 2/5 67 l., SE, or Cocoanut Pt.	0 56	128 27
	Weda Is., [3 l.]. E lim. ○	0 40	128 39
	Iyor, [5m.], S pt.	0 3	129 34
	Gebv. 6/5 7 l., Port Fou, on SW side, ⊞, w, r	0 6	129 21
		North	
	— North-West pt.	0 2	129 15
	Shampee Is., 3 or 4, NS 3 l.	0 30	128 43
	Canton Packet shl., 4f.	0 35	128 55
	Catherine Is., 3, *l.*	0 41	129 5
	Aidassier Islet	0 45	129 0
	Aurora bk , 5f.	0 43	129 23
Gilolo, E. Coast	Weda, ‡	0 18	127 52
	Dilegisa Pt.	0 15	128 31
	Po. M ar, ⚓, *l*, ‖₀	0 7	128 55
	Wossa, village, w, r, b	0 35·5	128 34
	Pt. Monat	1 1	128 28
	Pt. Waigamele, (rks 1 l.)	1 9	128 38
	Pt. Salaway, (rks. 1 l.)	1 33	128 43
	Watering-place, N of Galela Tiabu	1 51	127 52
	Bisoa Pt. ○	2 13	127 55
	Rau, [2 l.], mid.	2 23	128 11
	Morty, 2/2 21 l., N pt., (rf.), T	2 44	128 20
	— South-West pt., Lints I.	1 57	128 13
Is. on West Coast of Gilolo	Toakara, N pt.	2 19	127 44
	Talabu Pt.	1 6	127 22
	Dyilolo, town	1 7	127 27
	Ternate, 4/4 6m., sum. 5180f , Fort Orange, on E side	0 48·0	127 21
	Tidore, [2 l.], sum. 5900f.	0 40	127 25
	Pottbakker I., [2m.], 1160f.	0 33	127 22
	Metir, [3 l.], sum. 2800f.	0 27	127 24
	Wolf rk.	0 12	126 53
	Makyan, [5 m.], sum. 4166f.	0 20	127 23
		South	
	Latta-Latta Is , Japi	0 17	126 59
	Grt. Tawally, 4/4 7 l, SW pt. Id.	0 29	127 3
	Batian, 4/4 17 l., *h*, Sebong I., (mid. of S coast)	0 54	127 34
	— Padang, Coal Station	0 44	127 25

(96)	Places	Lat.	Lon. E
		North	
Is. to N.W. and N. of Gilolo	Tifori, sum. 587f.	1° 0′	126° 8′
	Mayo, N pt. 1280f.	1 21·1	126 21·7
	Biarro, sum.	2 7	125 25
	Roang, vol., 2330f.	2 18	125 22
	Siao, pk., 5924f.	2 44	125 23
	Makaléhé I., 394f.	2 42	125 12
	Nennung Is., South I ○	3 2	125 41
	Kalama, ‖ North I., N extr.	3 15	125 27
	Sangir, 2/2 8 l., Taruna B., w, r	3 33	125 28
	— North pt., Salima	3 45	125 27
	Louisa shl.	4 0	125 18
	Haycock Is., Kabalusu	4 15	125 19
	— Meares, South pt.	4 39	125 26
	Anda I.	4 34	125 38
	Ariaga I.	4 44	126 28·5
	Charruca shl.	4 45	125 38
	Iphigenia rks. South rk.	4 15	125 45·5
	Nanusa Is., Merampi Pk., 666f.	4 46	127 7
	Talauer Is., NS 15 l., N pt., Mamaga	4 34	126 48
	— Nusa I.	4 18	126 43
	— Salibabu I., 2/2 5 l., S pt.	3 48·5	126 42
	— Kaburuan, 4/4 3 l., S pt.	3 45	126 49
	Northumberland shl., [2m.]	3 39·5	126 51
Is. N.W. of New Guinea	Eye I., [½m.]	0 22	129 56
	Syang, [3m.], *l*, w, SW pt. I.	0 18	129 55
	Wyang, or Vayag Is., 6/5 6 l., NW extr., Laborde Islet	0 13	130 3
	— SE extr, Labishe I., [1m.], (rks. SE)	0 5	130 15
	Eon, or Iue Is., EW 4m., E pt.	0 8	130 19
	Ormsby shl., T N, N pt.	0 44	130 2
	Budd I., *l*, ⚓ ⦶	0 27	130 51
	Au Is., about 20 small, *l*, δ, rfs T, Wirisoi	0 41	131 9
	Au Baba, [3m.]	0 21	131 7
	Asia Is., 3, *l*, SW and smallest	1 0	131 15
	Po Manuaran, [2m.], ‖ S, w	0 2	130 57
		South	
	Buccleuch shl., [3m.], 4 ?, 5	0 16	131 30
	Waigin, EW 22 l., SE pt., or Pt. Pigot	0 21	131 12·0
	— Boni I , [¾m.], ⊞ SW-d., N pt.	0 1·7	131 8
	— Offak Harbour, ⊞, w, entr.	0 1·8	130 43
	— NW pt., C Forrest	0 5	130 12
	Buttons, [1m.]	0 1	130 24
	Ruib, NS 6m., pk.	0 2	130 9
	Balabalak, [2m.], W pt.	0 2	130 4
	Gag I., [7m.], N pt.	0 20	129 55
	Pigeon I., ⚓, ⤳, W pt.	0 39·7	130 34 ?
	Battantà, EW 15 l., W pt. C. Mabo	0 54	130 25
	— Marchesa Bay, Toe Pt.	0 49·5	130 54·?
	Salawatti, 10 l., Dady Pt.	0 58	130 38

MARITIME POSITIONS

(97)	Places	Lat. S	Lon. E
	NEW GUINEA.		
New Guinea, S.W. Coast	Brebes Pt., or C. Wilson ...○	0°40′	131°57′
	Threshold Pt. ....○	0 47	131 27
	C. Spencer, or Foul Pt., (rfs. 2m.)	0 52	131 15
	Selé Pt.	1 27	130 57
	W. Brother, or Pinion I.	1 47	131 6
	Sabra Pt.	2 2	131 57
	Pisangs Is., Po. Sabuda, SW pt.	2 39·5	131 38
	Mac Cluer's Inlet, Head, or E lim. of the bay	2 10	133 46
	Tatingar Pt.	2 48	132 1
	C. Sapey, (sum. 3020f.), W pt. (Balk)	3 41	132 42
	C. Kaffura	4 7	132 55
	Po. Adi, or Wessels, $\frac{61}{16}$ 8 l., W pt. ⚓	4 9	133 20·5
	Bird I., [$\frac{1}{3}$m.] (Vogel)	4 21	133 36
	Lamansiere Hill, NW sum. 2460f.	3 44	134 7
	Triton B., Fort Dubus	3 47	134 7
	Lakahia Mt., 4564f.	4 10	134 45
	Charles Louis Mts., 9510f. ...	4 9	136 15
	C. Buru, vis. 10 l.	4 12	134 45
	Vlakke Pt.	4 27	135 10
	Wamuka R., mouth ....○	4 40	136 15
	C. Steenboom.....................	4 50	136 29
	Snowy Mountains, sum. 14,000f.	4 13	137 7
	Dourga Strait, E pt.	7 22	138 34
	C. Valsche, (W pt. of Frederick Henry I., $\frac{6}{61}$ 36 l.)...	8 22	137 40
New Guinea, S. Coast	St. Bartholomew I.	8 17	139 28
	Deliverance I., small, rfs. ...○	9 35	141 47
	Mt. Cornwallis, vis. 9 l.	9 25	142 31
	Bristow I., [5m.], *l*, ⚘, SE pt.	9 9	143 14
	Fly River, Tree I.	8 41	143 36
	Aird Hill, 1260f.	7 28	144 20
	Blackwood, Pt., *l*, ⚘	7 52	144 28
	Mt. Yule, 10,046f.	8 14·5	146 46
	C. Possession	8 36	146 22
	Port Moresby, Jane I.	9 25·5	147 7
	C. Hood	10 7	147 42
	C. Rodney, SE pt.	10 12	148 22
	Dufaure I., [1 l.], sum.	10 29	149 48
	South Cape, Suau	10 43·5	150 14·2
Louisiade Islands.	Adele I., [2c.], *l*, [⚘], ‖₀ W...	11 29	154 26·5
	Rossel I., EW 7 l., *l*, ⚘, ‖₀ W. C. Deliverance.........	11 23·3	154 17·7
	Sudest I., Mt. Riu 2645f. ...	11 30·6	153 26
	Fox, or Renard Is. ? [4 l.], W pt.	10 54	152 58
	St. Aignan I, EW 10 l., E pt., C. Henry	10 41	152 55
	Deboyne Is., [2 l. ?], N pt. ...	10 40·5	152 23
	Bonvouloir Is., E extr.	10 25	152 6
	Laseine Is., [2 l.], Dawson I.	10 23	151 25·5

(98)	Places	Lat. S	Lon. E
	Ouessant I., small	11° 8·6	151°15′5
	Teste I., (Wari), East I.	10 58	151 5·2
	Moresby I., Fairfax Pk., 1740f.	10 36·8	151 0·5
	CHINA ST., SAMARI I. MISSION	10 36·8	150 39·7
	Lydia I., (Nuakata), pk., 1010f.	10 16	151 0·5
	Possession B.	10 34·6	150 42·2
	East Cape, Anchor I., E pt....	10 13·2	100 53·7
	D'Entrecasteaux Is., S pt., C. Ventenat, (Is. S-d.) ...	10 10·7	151 13·5
	Welle I., [2 l.], E part, (rfs.)	9 37	151 3
	Goodenough I., pk., 7000f. ...	9 21·5	150 14
	C. Vogel, Glen I.	9 45	150 4
	C. Nelson	8 59	149 20
	I. Riche, Mitre rk.	7 59	148 9·5
	Pocklington shl., EW 10 l., rks., δ E rk.	10 45·4	155 51·7
	Laughlan Is., 9, EW 5m., *l*, †, low E rk.	9 19	153 40
	Cannac rk., ⚘, high	9 18	153 28
New Guinea, North Coast and Outlying Islands	Woodlark Is., $\frac{6}{5}$ 13 l., P′, North point.................	9 3·5	152 47
	— West Rock	9 16	152 13
	Yanaba, Sharp I. ....○	9 29	152 40
	Jouveney I., [2m.]	8 45	151 45
	Jurien I., [1 l.], mid.	8 39	151 22
	Lagrandière I., [2 l.], E pt. ...	8 52	151 8
	Trobriand Is., C. Denis	8 24	151 4
	Lusancay Is., & rfs., EW, & others W-d, unexplored, NE ext., North I.	8 23	150 48
	C. Cretin, Cretin Is.	6 43	147 53
	C. King William	6 2	147 37
	Mount Disraeli, 11,000f..........	5 58	146 29
	C. Rigny	5 29	145 58
	Rich I., [1 l.], *h*..................	4 49	146 13
	Dampier I., $\frac{4}{4}$ 5 l., ab 5000f.	4 40	145 58
	Vulcan I., [2 l.], conical, 4000f	4 5	145 2
	C. della Torre....................	3 51	144 31
	Lesson I., [2m.], *h*, conical ...	3 33	144 48
	Blosseville I., [1m.], 1100f. ...	3 36	144 34
	Garnot I., [3m.], conical	3 30	144 35
	Jacquinot I., [3m.], †	3 24	144 24
	Deblois I., [$\frac{1}{2}$ l.].................	3 21	144 9
	Roissy I., [1 l.], † †, N pt....	3 12	144 3
	Victoria Bay, D'Urville I.......	3 16·4	143 29
	D'Urville I., [3 l.], pk. near W end........................	3 17	143 30
	Gilbert I, [4m], *l*, E pt., (rf.).....	3 13	143 17
	Bertrand I., *l*, ‖ W, ⚘	3 10	143 10
	Torricelli Mountns, W sum. 4 l. inland	3 21	142 12
	Eyries Mt., very *h*, W sum. 3 l. inland	2 50	141 15
	Mt. Bougainville	2 40	140 51
	Humboldt B., Obsn. I.	2 36	140 42·3
	Cyclops Mt., vis 20 l., E sum.	2 31	140 30
	Pt. Brama, hill	2 18	139 52
	Aru I., [1$\frac{1}{2}$m.], 2 Is. W-d. ...	2 7	139 27
	Jamna I., [1m.]	1 56	139 12
	Jomi or Moa Is, $\frac{4}{4}$ 2 l., N I.	1 37	138 41

MARITIME POSITIONS

Region	(99) Places	Lat. S	Lon. E
New Guinea, Geelvink Bay	C. D'Urville, *l*, ☨, (riv. W-d. ?)	1°24′	137°47′
	Karudu I., E pt.	1 48	137 2
	Jappen I., Ansus Harbour	1 44	135 49
	Nau I.	2 19	136 19
	Ter-chelling Is., E pt.	2 55	135 54
	Haerlem Is., [4 l.], W one	3 5	135 52
	Pt. Pinxter, W pt.	3 24	135 46
	Hoog, South pt.	2 51·5	135 5
	Angermus I., E pt.	2 38	135 3
	Meosaui I.	1 57	134 48
	Job I.	2 33	134 24
	C. Oran Swari	1 22	134 17
	Mefur I., 164f.	1 1·5	134 53
	Mysory Is., 6/6 20 l., *h*, E pt.	1 10	136 45
	— Mt. Schouten, Kaiori, 1640f.	0 47	135 37
	— W pt., C. Saavedra	0 38	135 19
	Mioskaroar I.	0 18	135 3
	Arfak Mountains, 9157f.	**1 11**	**133 59**
	Port Dorei, Manaswari I.	**0 54**	**134 7**
	C. Mamori	0 48	134 8
	C. Maiami	0 29	133 12
	C. Good Hope	0 19	132 21
	Mt. Diceras, 8m. inland	0 32	132 17
	Mispalu Is., Amsterdam I.	0 19	132 9·0
	AUSTRALIA, North Coast.		
	Duythen Pt.	12 34	141 41
	Pera Hd., *l*. ⊥	12 59	141 40
	C. Keerweer	13 58	141 34
Gulf of Carpentaria	Van Diemen's Inlet, w. entr.	16 58	141 1
	Norman R., Kimberly Tel. Stn.	17 26·6	140 56
	Albert R., Kangaroo Pt.	17 35·1	139 49·5
	Wellesly Is., N extr., rocky islet	16 18	139 26
	— Pisonia I., small	16 29	139 56
	— E extr., Bountiful Is., 2, 4/4 3m., E pt.	16 39	139 59
	— Sweers I., 2/2 5m., ☨, w, r̄, b, S pt., Inspection Hill, 105f.	17 8·2	139 41
	Sir Ed. Pellew's Is., 6/6 12 l., N extr., a rk.	15 29	137 4
	— Vanderlin I., 2/2 6 l., N pt., or C. Vanderlin	15 34	137 8
	— West I., NE pt.	15 32	136 46
	Maria I., 4/4 7m., N pt.	14 50	135 54
	Groote Eylandt, NS 12 l., SE pt., (an I. S 5m.)	14 16	136 58
	— Central Hill, vis. 10 l.	13 57	136 41
	North-East Is., [7m.], E extr.	13 39	137 1
	Bickerton I., [4 l.], sum.	13 45	136 15
	Woodah I., 2/2 4 l., S pt.	13 34	136 13
	Nicols I., [3m.]	13 27	136 19
	C. Shield	13 20	136 23
	C. Grey	13 0	136 42
	Mt. Caledon	12 53	136 33
	Mt. Alexander	12 39	136 44
	C. Arnhem	12 16·5	137 0
	Brumby Is., NE pt.	11 46·5	136 42
	C. Wilberforce ○	11 53	136 35
	Truant I., small	11 39	136 48
	Wessel's Is., C. Wessel, 180f.	10 59	136 45
	Arnheim B., entr., Mallison's I., W pt.	12 11	136 6
	Brown's Strait, Pt. Dale	11 36	136 5

Region	(100) Places	Lat. S	Lon. E
North Coast	Crocodile Is., North I.	11°41′	135° 9′
	C. Stewart, rky.	11 57	134 46
	Liverpool R., Haul-round I.	11 54	134 15
	Pt. Cuthbert, (shls. 3 l. out. ‖)	11 43·5	133 51
	Goulburn Is., North I., 4/4 7m., N pt.	11 28	133 30
	Pt. Brogden, rky.	11 31	133 6·5
	De Courcy Hd.	11 21	132 57
	Mac Cluer I., 4/4 2m., N pt.	11 4	133 1
	New Year I., small, w	10 55	133 4·5
	Money shl., [5m.], ⚓	10 21·5	132 45·7
	Croker I., NS 7 l., N pt., C. Croker, (rks NW-d.)	10 58	132 37
	Orontes rf., [1m.], ⚓	11 4	132 6
	Pt. Smith, [rks. 1m.]	11 8	133 9
	PORT ESSINGTON, Gov. Ho.	11 22	132 9·2
	Vashon Hd., (shl. 2m.), N pt.	11 7	132 0
	C. Don, 130f.	11 18	131 46
Melville I., Van Diemen Gulf	Burford I., [1m.]	11 31	131 56
	Greenhill I., NS 5m., Webb Pt., (rf. off)	11 39	132 4·7
	Field I., [4m.] *l*, (off mo. of S. Alligator R.), W pt.	12 5	132 21
	C. Hotham, shl. NE-d.	12 3	131 18
	Vernon Is., [3 l.], S side of Clarence Strt., W pt.	12 3	131 0
	Melville I., 6/6 25 l., E pt.	11 28	131 34
	— Pt. Jahleel	11 9	131 18·2
	— N and W pt., C. Van Diemen, *l*, sandy, (shl. 5m.)	11 8	130 20
	Bathurst I., Brace Pt.	11 18	130 16
	— C. Helvetius	11 41	129 58
	— S extr., C. Fourcroy	11 51	129 57
	North-West Coast.		
North-West Coast	PORT DARWIN, PALMERSTON, E extr. of Cable Ho.	12 28·4	130 50·5
	Port Paterson, ⊞, Raft Pt., on E side	12 37	130 33·2
	Paterson's B., Quail I., w‴	12 31	130 26·7
	Pt. Blaze	12 51	130 11
	Peron Is., 2/2 5 l., N pk.	13 9	130 2
	C. Ford, (rks. 2m.)	13 28	129 55
	Port Keats, ⊞, Tree Pt.	14 1·5	129 38
	C. Hay, (shls. 2/2 5 l.)	14 3	129 32·2
	Pt. Pearce, 85f., (a rf. off)	14 26	129 21·5
	Cambridge G., Lacrosse I., 6/6 4m., W pt., 600f.	14 43	128 17
	— Wyndham	15 28	128 3·2
	C. Dussejour, (rk. off), sum over	14 42	128 13
	Mt. Casuarina, 800f.	14 23	127 39
	Lesueur I., [and rks. 1 l.]	13 48	127 15·5
	C. Londonderry, (Stewart Is., 20f., and rks. 3m.)	13 42	126 54·7
	C. Talbot	13 46	126 45·2
	Jones I., 10f., small, *l*, sandy	13 43·2	126 25
	C. Bougainville	13 52	126 11
	Troughton I., 20f., sandy, [rfs. 5m.]	13 44	126 13·5
	Shls., bks., [Holothuria and others], unexplored, W lim.	13 32	125 48
	Cassini I., 20f., [3m.], rfs. N	13 55	125 44

MARITIME POSITIONS

	(101) Places	Lat. S	Lon. E
North-West Coast	Admiralty Gulf, Port Warrender, Crystal Hd.	14°28′	125°58′
	C. Voltaire, flat hill, (1½m. inland)	14 13	125 41·5
	Condillac I., small	14 6	125 38
	Montalivet Is., W extr. shl.	14 14	125 6
	Maret Is., (rfs. W 2 l.), N pt.	14 23	124 57
	Lamarck I.	14 45	125 2
	C. Pond, islet off	14 45	125 9
	Pt. Hardy	14 58	125 2
	Port Nelson, ⊞, Careening B. beach	15 6	125 1
	Prince Regent's R., Mt. Trafalgar, sum	15 16	125 4
	Port George IV., ‡′, w′, b, rfs., Augustus I., Adieu Pt.	15 13·5	124 34
	Colbert I.	14 51	124 42
Buccaneer Archipelago	Freycinet grp., W island	15 0	124 32
	White rock islet	15 4	124 19
	Red I.	15 13	124 13·2
	Champagny Is., $\frac{16}{6I}$ 7m., Degerando sum.	15 19	124 10
	Adele I., [rfs 4m.], 8f., ✻₀	15 32	123 14
	Beagle bk., [β 5m.], 15f.	15 19	123 30
	Pt. Hall, sum	15 40	124 21
	Doubtful B., Raft Pt., w	16 3·5	124 26
	Cockell's Is., [2 l.], W pt	15 46	124 4
	Mac Leay Is., N extr. reef	15 54	123 39
	Caffarelli I., $\frac{16}{6I}$ 2½m., mid.	16 3	123 18
	Brue rk.	15 57	123 4
	Hidden I., W pt.	16 14	123 27
	High I., [2m.], 290f.	20 20	123 20
	Port Usborne, [¾m.], 7, w	16 39	123 30
	King's Sound, Pt. Torment	17 0	123 35
	— Derby	17 20	123 39
	— FitzRoy R. mo., Escape Pt.	17 24·4	123 34
	— Pt. Cunningham, NW part	16 41·5	123 7
	Skeleton Pt., w′	16 31	123 0
	Swan Pt.	16 21	123 1·7
	C. Leveque, 83f., (an islet off)	16 22	122 55·5
Islands and Shoals N.W. of Australia	Rowley shls., Impérieuse shl. NS 3 l., N. Sandy I., 8f.	17 32	118 51
	— Clerke's rf., or Minstrel shl., N Sandy I., 8f.	17 16	119 21
	— Mermaid shl., [3 l.], passage on E side	17 5	119 38
	Scott rf., a lagoon, NS 6 l., T W, I. sand and crl., Sandy I., 8f.	14 3	121 49
	Seringapatam rf., EW 5m., 2f., T, N pt.	13 34	122 3
	Browse I., [1m.], *l*, 20f.	14 7	123 33·5
	D'Artagan shoal, $\bar{10}$	13 16	120 38
	Corona shoal, $\bar{5}$	12 26	118 40
	Dry sand, 10f., (Ship Cartier, 1800)	12 32	123 38
	Hibernia rf, 1810	12 0	123 24
	Ashmore shl., Middle I.	12 15	123 4
	Troubadour (1843), $\bar{9}$	9 44	128 28
	Coral bank, $\bar{7}$	9 57	129 27
	Lynedoch, shl. [¾m.], $\bar{7}$	9 54	130 40

	(102) Places	Lat. S	Lon. E
AUSTRALIA, North-West Coast	C. Borda	16°40′	122°43′
	Beagle B., N Hd.	16 50	122 32
	Lacepede Is., W one, [and rks. 3 l.], 15f., sand	16 50	122 8
	C. Baskerville	17 9	122 16·5
	Pt. Coulomb, rf. 1m.	17 21	122 10
	C. Boileau, sandy	17 38	122 10
	Pt. Gantheaume	17 58	122 11
	C. Villaret, 150f.	18 19	122 4·5
	C. Latouche Treville, 250f.	18 28	121 51·5
	C. Bossut, Casurina rf.	18 43	121 37
	C. Jaubert, 45f.	18 58	121 36·5
	Mt. Blaze, 60f.	19 59·5	119 38
	Amphinome shls., outer β	19 43	119 19
	Bedout I., 20f., rf. SW, [½m.]	19 35	119 6
	Turtle I., 35f., [½m.], 1f., r̄	19 54	118 55
	Port Headland, Hunt Pt.	20 18·2	118 35·7
	C. Thouin, rf. N.	20 20·5	118 13
	Geographe shls., 2, NW one, [1m.]	20 16	117 55·5
	Depuch I., ww₀, 514f.	20 38·4	117 44·5
	Port Walcott, (Tien Tsin Hr.), Cossack, lt. F 97f. on Jarman I.	20 39·1	117 13·2
	Port Robinson, Dixon I.	20 38	117 3·2
	Legendre I., 55f., $\frac{6I}{6}$ 8m., NW pt.	20 21	116 51
	Dampier's Archipelago, $\frac{16}{6I}$ 10 l., Rosemary I., [3m.], W sum. 250f.	20 29	116 36
	Hampton Hr., Channel I.	20 39·8	116 42
	C. Preston	20 50	116 12·5
	Montebello Is., NS 4 l., ‖₀, Ritchie rf.	20 18	115 23
	— Tremouille Is., ✻, w₀, b, flag islet, 21f.	20 28	115 35
	— Tryal rks., NS 4m., N extr.	20 35	115 27
	Barrow I., $\frac{12}{2I}$ 4 l., r̄, (rf 16m. from S end), C. Dupuy	20 40	115 27
	Fortescue R., mouth	20 59·8	116 6
	Rosily I., 21f.	21 18·5	114 59·5
	Ashburton R., (Onslow), mouth	21 40·7	114 56·2
	N Muiron I., pk. 70f.	21 37	114 23
	NW Cape	21 46·5	114 10
	West Coast.		
	Exmouth Gulf, B. of Rest, N pt.	22 15	114 7·2
	Pt. Cloates	22 43	113 41
	C. Farquhar, sand, *l*	23 35	113 39·5
	C. Cuvier, 400f., ⊥, rock off	24 13	113 23
	Bernier I., $\frac{12}{2I}$ 4 l., Koks Id. off N pt. ○	24 44	113 10
	Dorre I., $\frac{12}{2I}$ 6 l., ⊥, T, (Dampier's rf. S 4m.), S pt., or C. St. Cricq	25 17	113 4
	Gascoyne Rd., Gascoyne R., beacon	24 53·5	113 39·5

MARITIME POSITIONS

(103)	Places	Lat. S	Lon. E
West Coast	Shark B., Dirk Hartogs I., 2/3 13 l., ⊥, N pt., or C. Inscription, W extr. of Australia	25° 29'·4	112° 58'
	— Cape Peron, 66f.	25 30·5	113 30
	— Baba B.	26 40 5	113 40
	St ep Pt	26 8 5	113 8 5
	Gantheaume B., Red Pt.	27 42	114 10·5
	Houtman rks., 2/3 16 l., ‡', ww$_o$, b, r, North I., [1⅓m.]	28 18	113 35
	— Wallabi grp., Evening rf., (Middle Channel S of do.), S pt.	28 33	113 41
	— North-East rf., [⅓m.]	28 25	113 50
	— Easter grp., [3 l.], (Zeewyk Chan. S of do.), Rat I., N pt.	28 42·5	113 47·5
	— Snapper bk., [2m.], ŝ	28 42	114 1
	— Pelsart grp., EW 4 l., SW part, Wreck Pt.	28 59	113 58
	Mt. Fairfax, 603f.	28 45·4	114 41·7
	Wizard Pk., 640f.	28 29 7	114 47·0
	Champion B., (Geraldton), Moore Pt., lt. R 110f.	28 47 1	114 35
	Port Dongara, or Denison, lt. F. Leander Pt. beacon	29 17 1	114 55·2
	Mt. Peron, (3 l. inland)	30 7	115 9
	Mt. Lesueur, (do.)	30 13	115 10
	C. Lescheohault	31 18	115 30
	Rottenest I., ŝ 5½m., lt. R 211f.	32 0·3	115 30·2
	FREEMANTLE, SCOTT'S JETTY	32 3·3	115 44·5
	Swan R., Perth, Gov. House	31 57 4	115 51·7
	Garden I., 2/3 5½m., NW pt.	32 8 9	115 39·5
	Coventry rk.	32 22	115 30
	Peel	32 27	115 44
	C. Bouvard	32 34	115 40
	Koombanah B., w, lt. F 117	33 19	115 39
	Busselton, lt. F 63f.	33 38	115 21
	Naturaliste, rf., [½m.], ŝf.	33 15	114 55
	C. Naturaliste	33 32	114 58
	Geographe rk	34 20	114 54
	South Coast.		
South Coast ⊕	C. Leeuwin, (rks. 2 l. out)	34 21	115 6
	Low Black Pt.	34 25	115 29
	Pt. D'Entrecasteaux, ⊥, vis. 10 l., (Id., l, rk., 3m. S)	34 52	116 1
	White topped rks.	35 4	116 13
	C. Chatham, vis 10 l., (Islets S)	35 2	116 28
	Pt. Nuyts, vis. 8 l.	35 5	116 38
	W Cape Howe, ⊥	35 9	117 40
	Eclipse Is., [1 l.]	35 12	117 53
	Maude rf., ββ$_o$	35 13	117 56
	Bald Hd., vis. 12 l., S pt.	35 7	118 1
	Breaksea I., lt. F 384f.	35 4	118 3
	King George's Sound, w, b, Princess Harb., ⊞, New Govt. buildings	35 2·2	117 54
	Mt. Gardner, sum.	35 0	118 8
	Bald I., 3m., (rk. S 1m.)	34 55	118 27
	Sealer's ledge	35 10	118 27
	Haul off rk.	34 43	118 40
	C. Knob, sum.	34 31	119 14

(104)	Places	Lat. S	Lon. E
	Pt. Hood, (Doubtful Is., 3m. E-d.)	34° 24'	119° 34'
	East Mt. Barren, vis. 14 l.	33 57	119 59
	Seals' Is., (rks. N), l	34 6	120 28
	Rocky islets	34 5	120 53
	Esperance B., W pt., Observ. I., small	33 56	121 46
	C. Le Grand, (islets off)	34 1	122 4
	Lucky B.	34 0	122 14
Recherche Archipelago	West grp., SWst I., [2m.]	34 3	121 31
	SW, or outer danger	34 21	121 41
	Mondrain I., NS 3½m., vis. 10 l., β, S sum.	34 10	122 14
	S extr. of Archip., Termination I., [1m.], vis. 9 l.	34 30	121 58
	Twin rks., [rfs. 2m., T]	34 24	122 12
	Draper's I., [⅓m.]	34 13	122 30
	Twin pks., vis. 9 l., (pks. ŝ 2m.)	34 1	122 47
	A break at times, SW one	34 18	122 53
	Douglas Is., [1m.]	34 10	123 6
	Middle I., 4m., b, w$_o$, SW sum	34 8	123 8
	C. Arid., rky., SE pt.	34 1	123 13
	C. Pasley, sum. 1½m. inland	33 56	123 28
	Pt. Malcolm, l, sandy (rk. 3m.), rk.	33 48	123 42
	SE Isles, [1 l.], mid.	34 20	123 28
	Pollock rf., [1m.], β, T	34 34	123 30
	Round I., small	34 5	123 50
	Eastern grp., NS 3 l., S extr.	33 52	124 4
	Pt. Culver, ⊥	32 55	124 30 5
	Pt. Dover	32 31·5	125 31
	Low sandy pt	32 22	126 28
	Hd. of Grt. Australian bight	31 29	131 10
	Nuyts rfs., outer detached	32 9	132 7
	Fowler B., Port Eyre Telegraph Office	31 59·7	132 26 7
	Pt. Bell, l	32 13	133 8 2
	Purdies Is., ŝ 5m, w$_o$, r$_o$, S l., 83f.	32 17	133 14·2
	Smoky B., Laura B.	32 14·5	133 49
	Is. of St. Francis, NS 2 l., w$_o$ r$_o$, Hart I., 65f.	32 39	133 8 5
South Australia ⊕	Yatala rf.	32 39	132 35
	Pt. Brown	32 33	133 51
	Streaky B., Port Blanche	32 48	134 13 2
	Olive I., [1½m.], 82f., rfs. N	32 44	133 58
	C. Bauer, ⊥, W pt.	32 44	134 4
	Pt. Westall, ⊥	32 55	134 3·5
	C. Radstock, ⊥	33 12·5	134 20
	Pt. Weyland, ⊥, Venus Hr.	33 15	131 37·5
	Waldegrave I., 120f., W extr.	33 36	134 40
	Waterloo B., SE pt.	33 39 3	134 52 5
	Flinders I., 7m., N pt. 205f	33 41	134 31
	Ward's Is., 162f.	33 45	134 10 5
	Pearson's Is, NS 2 l., 2 pks., S l. 460f.	34 00	134 14
	Pt. Drummond, ⊥	34 9	135 14
	Coffin's B., Pt. Sir Isaac	34 26	135 12
	— Port Douglas, Coffin Hd. Station	34 37	135 28·2
	Greenly Is., [1 l.], pk. 755f.	34 39	134 47
	Whidbey Is., [2 l.], W grp., 362f., 4 hummocks, S extr.	34 47	135 1 5

MARITIME POSITIONS

(105)	Places	Lat. S	Lon. E
Spencer Gulf ⊕	Rocky Isl., small, *l*	34°49'	134°43'
	Stuart rf.	34 49.5	135 22
	C. Wiles, ⊥	34 57	135 41
	Liguanea I., [illegible] 2m., rf. S-d	35 0	135 37
	C. Catastrophe, S pt. ⊥	35 59	136 0
	William's I., [1m.]	35 1.7	135 58.5
	Neptune Is., *l*, S I., 120f.	35 20.5	136 7
	Gambier's Is., S pt., peaked rks	35 12	136 30
	Dangerous rf.	34 49	136 12.5
	C. Donnington	34 43.5	135 59.5
	Port Lincoln, ⊞. w, Church	34 43.3	135 51.5
	Pt. Bolingbroke, *l*, ⊥	34 33	136 4
	Sir Jos. Banks grp., S extr., Stickney I., 100f.	34 41	136 16.5
	—Winceby I., 33f., N pt.	34 29.2	136 17.5
	South B., Shipping place	34 23	135 55.5
	Franklin Harbour	33 44	136 57.2
	Pt. Lowly, lt. Fl 57f.	33 0	137 47.2
	Port Augusta, fl. st	32 29.7	137 45.7
	Mt. Brown, ab. 3174f.	32 30.7	138 1
	Germein, lt. on pier F	33 2	137 59.2
	Port Pirie, jetty	33 10.5	138 1
	Port Broughton, jetty	33 36	137 55.2
	Pt. Riley, ⊥	33 53	137 56
	Wallaroo, pier, lt. F 23f	33 55.5	137 37.2
	Tipara B., (Moonta), lt.	34 3	137 34
	Pt. Pearce, Wardang I.	34 30	137 19.5
	Port Victoria, Wauraltee, lt. F	33 29.2	137 29
	Port Minlacowie	34 51	137 27.7
	Port Turton, jetty	34 56.5	137 21
	Corny Pt., β, lt. F 98f.	34 54	137 0.5
	C. Spencer, Sst. of 3 pts., 258f.	35 18.5	136 53
	Althorpe Is., lt. Fl. 350f.	35 23	136 51.5
	Port Moorowie	35 7	137 31.5
St. Vincent Gulf ⊕	Troubridge, lt. R 81f.	35 7.5	137 49.7
	Edithburgh, lt. F	35 5.5	137 45
	Port Vincent, Surveyor Pt.	34 47	137 51.7
	Port Alfred, Kooley Wurta	34 37.4	137 53.2
	Androssan, lt. F	34 26	137 55.5
	Port Wakefield, lt. F	34 12	138 8.7
	PORT ADELAIDE, SNAPPER PT.	34 46.8	138 30.7
	Adelaide, town hall	34 56.2	138 35.7
	Mt. Lofty, 2330f.	34 59.2	138 42.5
	Glenelg, lt. F 29f.	34 59	138 30.5
	Port Noarlunga, jetty	35 9.6	138 28
	Port Willunga, S jetty	35 16.4	138 27.5
	C. Jervis, *h*, lt. F	35 37	138 6
	Kangaroo I., EW 28 l., N pt., Pt. Marsden	35 34.5	137 38
	C. Borda, lt. R 510f.	35 45.7	136 35.2
	— SW extr., C. Couedie, 95f.	36 4.5	136 42.2
	— Pelorus rk., 40f.	36 7.3	137 31.5
	— C. Willoughby, lt. R 247f	35 51	138 8
S. Australia ⊕	Port Victor, Harb. Master's house	35 34.1	138 37.5
	Murray R., Goolwa jetty	35 31.2	138 47.2
	C Bernouilli, (C. Jaffa), lt. R 100f., *l*, sandy	36 57	139 40
	Robe, C. Dombey, obelisk, 76f	37 10.2	139 44.7
	Rivoli B., Penguin I., S pt.	37 31	140 1.2
	W. Cape Banks, sandy, lt. R 92f.	37 54.5	140 23
	C. Northumberland, lt. R 150f.	38 4.2	140 40

(106)	Places	Lat. S	Lon. E
Coast of Victoria ⊕	Glenelg R., entrance	38° 3'.7	140°59'.5
	C. Bridgewater, ⊥, 441f.	38 22	141 24
	C. Nelson, ⊥, lt. F 250f.	38 26	141 33
	Portland B., Laurence rk.	38 24.6	141 40.5
	Percy I., [1m.], ⊥, 153f.	38 25.2	142 0.5
	P. Fairy, (Belfast), Griffith I., lt F, Fl. 41f.	38 23.8	142 15
	Lady B., (Warrnambool), Middle I., (lts. F 100f. and 87f.)	38 24.3	142 28.5
	C. Otway, *h*, ⊥, lt. R 300f.	38 51.7	143 31
	Apollo Bay, *h*, lt. F	38 45.7	143 41
	Louttit Bay, Mt. Saint George, 657f.	38 33.9	143 57
	PORT PHILLIP, MELBOURNE, NEW OBSERVATORY	37 49.9	144 58.5
	— Pt. Lonsdale, lt. F 54f.	38 17.7	144 37
	C. Schank, lt. F, Fl. 328f.	38 29.7	144 53.2
	Phillip I., [illegible] 10m., w, W pt., Pt. Grant	38 31.6	145 7
	C. Liptrap, ⊥, pt.	38 55	145 56
	Glennie Is., NS 3m., 456f., S pt.	39 7	146 15.5
	Cleft I.	39 10	146 20
	S pt. of Australia, Wilson's Promontory, ⊥, lt. F 342f.	39 8	146 25.5
	Mt. Wilson, 2350f.	39 3.5	146 24.5
	Bass Strait.		
	King I., NS 35m., N pt., C. Wickham lt. F 280f.	39 35.6	143 57
	— S Pt., *l*, C. Stokes	40 10	143 56
	— Harbinger rks., 2, [illegible] 2m., ‖ 27, outer, or SW rk.	39 34	143 52
	— New Year Is., w, NW rk.	39 40	143 49
	— Currie Hr., lt. Fl. 150f.	39 56	143 51
	Reid rks., [3m.], NW, 25f.	40 15	144 10
	Bell rf., 1m., S end	40 24	144 5
	Black Pyramid, 240f.	40 28	144 21
	Redondo, rk., ⊥, 1130f.	39 14	146 23.5
	Moncœur Is., small, E extr.	39 14	146 34
	Crocodile rk.	39 21.5	146 30.5
	Curtis I., [2m.], 1060f., (Sugar loaf, S 3m.)	39 28.5	146 39
	Devil Tower, ~, 350f.	39 23	146 47
	Hogan I., [1⅓m.], 430f.	39 13	147 1
	Judgment rk.	39 30	147 10
	Pyramid, 300f.	39 49	147 16
	Kent Is., 3, [illegible] 6½m., Deal I., w, b, lt. R 957f.	39 30	147 19
	Wright rk., small, 200f.	39 35	147 32
	Endeavour rf., Beagle rf., and Craggy I., [illegible] 8m., S pt., or Craggy I.	39 41	147 42
Furneaux Is.	Sisters, 2, [illegible] 7m., NE one, sum. 636f.	39 39	147 59.7
	Flinders I., [illegible] 36m., W pt., or C. Frankland	39 52	147 46
	— Streleski pks., 2, at S part, 2550f.	40 12	148 6
	— Babel Is., off E side, sum.	39 58	148 21.5
	Hummock I., [illegible] 6m., Low Furneaux Is. off S pt.	40 7	147 44.5

MARITIME POSITIONS

	(107) Places	Lat. S	Lon. E
Banks Strait	Goose I., [1½m.], ✠, S pt., lt. F 100f.	40°19′	147°48′
Banks Strait	Barren I., EW 23m., Mt. Munro, on NW part, 2300f.	40 22·4	148 7·5
Banks Strait	Preservation I., pk.	40 29	148 4
Banks Strait	Clarke I., ¾ 8m., S pt.	40 35	148 10
Banks Strait	Look-out rk., (SW of do.)	40 33	148 7·5
Banks Strait	Moriarty bk., SE pt.	40 36	148 17
	TASMANIA.		
West Coast	C. Grim, ⊥, *blk.*	40 40	144 40·7
West Coast	West Pt., sandy	40 57	144 38
West Coast	Mt. Norfolk	41 28	144 57
West Coast	Mt. Heemskerk, vis. 10 l.	41 54	145 10
West Coast	Macquarrie Harb., ⊞, bar 5f., ✠, w, r̄, entr. I.	42 11·6	145 13·5
West Coast	C. Sorell, *l*, rky. pt.	42 11	145 10
West Coast	Pt. Hibbs, β 2m.	42 38	145 15
West Coast	Rocky Pt., a rf.	43 0	145 30
West Coast	Mt. de Witt, vis. 12 l.	43 10	145 50
West Coast	Port Davey, ⊞, w, b, pyramidal rk., entr.	43 20	145 55
West Coast	Sugarloaf rks.	43 25	145 56
West Coast	South-west C., 1000f., ⊥	43 35	146 1
South Coast ⊕	South C.	43 39	146 53
South Coast ⊕	Maatsuyker Is., ¾ 7m., SW, or Needle rk.	43 41	146 11
South Coast ⊕	Mewstone, *h*, rugged, ‖ N	43 44·5	146 23
South Coast ⊕	Pedra Blanca, (Eddystone 1m. E), ‖₀	43 51·5	146 59·5
South Coast ⊕	Sidmouth r̄k., [½c.]	43 47·5	147 7
South Coast ⊕	Rurick r̄k.	43 59	147 42
South Coast ⊕	Recherche B., 2 ⊞, w, b, S port	43 34	146 54
South Coast ⊕	Huon R., Swan Port, ⊞, ✠,	43 14	147 5
South Coast ⊕	Actæon r̄f.	43 34	146 59
South Coast ⊕	Bruny, Id., ½ 9 l., S pt., or Tasman's Hd., ⊥	43 31	147 19·2
South Coast ⊕	— SW pt., or C. Bruny, lt. R 335f.	43 28·7	147 8
South Coast ⊕	— Fluted Cape	43 22	147 24
South Coast ⊕	HOBARTON, ⊞, FORT MULGRAVE	42 53·4	147 20·5
South Coast ⊕	Storm B., C. Raoul	43 13	147 47
South Coast ⊕	Port Arthur, ⊞, w, r̄, Semaphore	43 9·1	147 50·7
South Coast ⊕	C. Pillar, ⊥, Tasman's I., off do., vis. 12 l.	43 14	148 2
East Coast	Hippolite rk., 70f.	43 6	148 2
East Coast	Maria I., NS 4 l., Oyster B., ww₀, W side, ‡	42 40	148 2
East Coast	— Pyramid, off S pt.	42 45	148 3
East Coast	— Sum. at N end, 3500f.	42 37	148 7·5
East Coast	C. Bougainville	42 30	148 0
East Coast	Schouten's I., 2½ 6m., S islet off	42 21	148 18
East Coast	C. Degerando	42 16	148 17
East Coast	St. Patrick's Head	41 34	148 18
East Coast	Eddystone Pt., lt. F, Fl. 132f.	40 59	148 20
East Coast	Mt. Cameron, (8 l. inland of do.), 1730f.	40 59	147 56
East Coast	Black rf., [1½m.]	40 50	148 16
East Coast	Swan Is., [3m.], 90f.; w, lt. at E pt., R 100f.	40 44	148 8

	(108) Places	Lat. S	Lon. E
Tasmania, North Coast	C. Portland	40°44′	147°57′·7
Tasmania, North Coast	Waterhouse I., ½ 2½m., ✠, ‡ SE s, N pt.	40 46	147 38
Tasmania, North Coast	Ninth I., small	40 50	147 17·7
Tasmania, North Coast	Mt. Arthur, 5 l. inland, 4300f.	41 16	147 17
Tasmania, North Coast	Tenth I., small	40 56·2	147 0
Tasmania, North Coast	Port Dalrymple, ⊞, Low Hd., lt. R 142f.	41 3·4	146 48·2
Tasmania, North Coast	Flinders Pt.	41 4	146 44
Tasmania, North Coast	Emu Bay, NW, or Blackman Pt.	41 3	145 57
Tasmania, North Coast	Valentine Pk., 7 l. inland, 4000f.	41 22	145 45
Tasmania, North Coast	Table Cape, lt. F 390f.	40 56·7	145 45·7
Tasmania, North Coast	Rocky Cape, sum 2m. inland, 1000f., (a rk. 2m.)	40 53	145 31
Tasmania, North Coast	Circular Hd., ⊥, 485f. N pt.	40 43	145 17
Tasmania, North Coast	Walker I., NS 3m., N pt.	40 35	144 55
Tasmania, North Coast	Three Hummock I., ¾ 7m., w, SW side	40 26·5	144 51·0
Tasmania, North Coast	Hunter I., NS 13m., 300f., ✠₀, ✱, ‡ E, N pt.	40 24	144 48
Tasmania, North Coast	North black rk.	40 29	144 39
Tasmania, North Coast	Albatross I., [1m.], 125f. sum.	40 22	144 39·7
	AUSTRALIA, East Coast.		
S.E. Coast	C. Wellington	39 4	146 29
S.E. Coast	Corner Inlet, ⊞, entr. S pt.	38 47	146 28
S.E. Coast	— Alberton, town	38 40	146 42
S.E. Coast	Is. to SE-d., ¼ 5m., E. or Cliffy I., lt. Fl 180f.	38 57	146 42
S.E. Coast	Gabo I., [1½m], lt. F 179f.	37 34·2	149 55
Coast of New South Wales ⊕	C. Howe, *l*, T, islet close off	37 30·2	149 58·7
Coast of New South Wales ⊕	C. Green, pt., lt. Fl. 144f.	37 15·5	150 3
Coast of New South Wales ⊕	Twofold B., Eden, ⊞, b, w,, Red Pt., lt. F 125f.	37 4	149 54·7
Coast of New South Wales ⊕	Mt. Dromedary, 2706f.	36 18·7	150 1·2
Coast of New South Wales ⊕	Montague I., [2m.], ‡, W, rky., lt F, Fl. 250f.	36 15·2	150 13·2
Coast of New South Wales ⊕	Pt. Upright, ⊥	35 38·7	150 19·5
Coast of New South Wales ⊕	Ulladulla Warden Head, lt. F	35 22·2	150 30·2
Coast of New South Wales ⊕	C. St. George, lt. alt. 224f.	35 9	150 46·5
Coast of New South Wales ⊕	Jervis B., Corranbean	35 3	150 40·7
Coast of New South Wales ⊕	Kiama, lt. F	34 40·5	150 52·2
Coast of New South Wales ⊕	Wollongong, lt. F 56f.	34 25·5	150 55
Coast of New South Wales ⊕	Botany Bay, ✠, ‡,, N pt. entr., C. Banks, 180f.	34 0·5	151 15
Coast of New South Wales ⊕	Port Jackson, ⊞, lt. electric, R 344f.	33 51·2	151 17·2
Coast of New South Wales ⊕	SYDNEY, FORT MACQUARIE*	33 51·5	151 13·0
Coast of New South Wales ⊕	Observatory	33 51·7	151 12·5
Coast of New South Wales ⊕	Broken B., ⊞, Baranju Hd., lt. F 370f.	33 34·7	151 20
Coast of New South Wales ⊕	Catherine Hill B., Coaling jetty	33 9·4	151 38·2
Coast of New South Wales ⊕	Newcastle, Nobby Hd., lt. 115f.	32 55·2	151 48·2
Coast of New South Wales ⊕	Pt. Stephen's, T, lt. R 126f.	32 45	152 12·5
Coast of New South Wales ⊕	Broughton Is., E pt.	32 37·5	152 21
Coast of New South Wales ⊕	Sugarloaf Pt., lt. Rev. 258f.	32 26·5	152 33
Coast of New South Wales ⊕	C. Hawke, pk., 777f.	32 13	152 35
Coast of New South Wales ⊕	Three Brothers, 1700f., N one	31 40	152 47
Coast of New South Wales ⊕	Port Macquarie, entr.	31 25	152 57
Coast of New South Wales ⊕	Smoky C.	30 56	153 6

* Garden Id., the [illegible] place of observation lies 0° 0′ 47″ E. of Fort Macquarie

MARITIME POSITIONS

Coast of Queensland ⊕

(109) Places	Lat. S	Lon. E
N. Solitary I.	29°55'5	153°24'
Clarence R., entr.. lt. F	29 26	153 24
C. Byron, E pt. of Australia	28 37.6	153 39
Mt. Warning	28 23.1	153 17
Fingal Pt., lt. F 80f.	28 11.2	153 34
Pt. Lookout, 260f.	27 26	153 33
C. Moreton, N part of Id., (rks ⚓ 4m.), lt. R 382f.	27 2.3	153 28
Brisbane R., Lytton I., lts	27 24.7	153 10
Mt. Arthur, 1620f.	26 17 5	152 50
Double I., pt., lt. R 315f.	25 56	153 12
Grt. Sandy I., ⚓ 23 l., E pt., or Indian Head	25 0	153 22
— N and E pt., Sandy Cape, w 7m., lt. R 400f.	24 42.5	153 12.5
— Shls. off N pt., Breaksea Spit, T	24 25	153 12
Maryborough R., Woody I., pk., lt. F 215f.	25 18	152 58.5
Burnett R., lt. F 37f.	24 45	152 24.5
North East Coast.		
Bustard Hd., lt. F, Fl. 330f.	24 1.5	151 46
Lady Eliott I., lt. Fl. 60f.	24 6 5	152 45 5
Mast-Head Islet, ⚘, 50f.	23 32	151 45
Capricorn grp., $\frac{2}{12}$, NW I., (rfs. E), ⚘, 50f.	23 16	151 44
— North rf., lt. F, Fl. 72f.	23 10.8	151 56
Port Curtis, (Gladstone), ⊞, Facing I., $\frac{2}{12}$ 8m., Gatcombe Hd., lt. F 66f.	23 53	151 22.7
C. Capricorn, lts. R and F.	23 29.5	151 14
Keppel Is., Barren I., 548f.	23 9.5	151 5
Rockhampton	23 24	150 32
Atherton	23 7.5	150 42
Flat I., 175f.	22 44	151 0
C. Manifold, islet, 260f	22 41	150 52
Port Bowen, ⊞, w, Obsn. rk.	22 31.7	150 47
C. Townshend, N extr., 500f.	22 12	150 30
High Double Mt., 2545f.	22 32.7	150 18.5
Thirsty Sd., Pier Hd., 334f.	22 6.5	150 3
Turn I., 280f.	21 59	149 49
St. Lawrence Creek, (St. Lawrence). S. Red Bluff.	22 17	149 37
Northumberland Is., E one, or High Pk., 718f.	21 57	150 42
Percy Is., $\frac{2}{12}$ 7 l., lt. F, Fl. 180f.	21 39	150 14
— Beverly Is., ⚓, Hull I., 272f.	21 27.5	149 53
— Prudhoe I., $\frac{4}{4}$ 2m., 1074f.	21 19	149 42
West Hill I., 983f.	21 49.4	149 30.7
C. Palmerston, (w ⚓ 10m.)	21 31.5	149 31
Pioneer R., (Mackay), Flattop I., lt. F 174f.	21 9.5	149 16
Slade Pt.	21 3	149 15
C. Hillsborough, ⊥, 996f.	20 54	149 3
Sir Jas. Smith's grp., Linné Pk., 926f.	20 40	149 12
Repulse Is., N. I. pk., 265f.	20 35.7	148 54
C. Conway, pk. 1637f.	20 31	148 54.5
Cumberland Is., $\frac{2}{12}$ 26 l., ⚘, S and E one, Snare Pk., 300f.	21 5.7	149 56 7

N.E. Coast of Queensland

(110) Places	Lat. S	Lon. E
Cumberland Is., Bailey I., 120f.	21° 3'	149° 34'
— Shaw's Pk., N part of I., [4m.], 1324f.	20 28	149 6
— Kenedy Sd., Brush I., 62f.	20 29	149 4
Dent I., lt. Rev. 120f.	20 22	148 57
Whitsunday I., pk. 1426f.	20 16	148 58.5
Hayman I., N pt., 844f.	20 2	148 54
Port Molle S' Hd., 225f.	20 19	148 52
Mt. Dryander, 2690f.	20 15	148 34.5
Gloucester Head, 1555f.	19 58	148 27
Port Denison, Obsy. Pt., W side of Stone I.	20 2.2	148 16 5
Nares rk., 26f.	19 46.4	148 22
Holborne I., [1m.], 360f.	19 43.6	148 22
Mt. Abbott, 3410f.	20 5.5	147 44.5
C. Upstart, (sum. 1510f), NW pt., (w $\frac{1}{2}$ 1m.) ⊕	19 42.2	147 45
C. Bowling Green, lt R 70f.	19 19.5	147 26
C. Cleveland, lt. R 206f.	19 11.2	147 1
Townsville Pilot Flagstaff	19 15.5	146 50.0
Mt. Eliot, 3980f.	19 29	146 58.5
Magnetic I., [5m.], 1628f.	19 8.5	146 49 5
— Bay rk., lt. F 96f.	19 7.2	146 45.5
Palm Is., b, w, large one, $\frac{4}{4}$ 8m., 1890f., SE pt.	18 45.5	146 42
Hinchinbrook I., Pt. Hillock, 270f.	18 25	146 23
— Mt. Bowen, 3650f.	18 20 7	146 17.2
— C. Sandwich, rks. 2m.	18 13 5	146 20
Cardwell	18 14 5	146 3
Rockingham B., Goold I., [2m.], w''' W, sum. 1375f.	18 9.5	146 11.5
Dunk I., $\frac{4}{4}$ 3m.	17 57	146 11
Double Pt., rks. SE 5m.	17 39.3	146 10.5
Flyingfish Pt., lts F	17 30.2	146 6.2
Frankland Is., $\frac{2}{12}$ 4m., S and E I., 220f.	17 13.7	146 7
Fitz Roy I., [2m.], w, b, NE pk., 860f., ⚓' W	16 55.7	146 1
C. Grafton, 1273f.	16 52	145 57
Cairns Landing-place, lts. F	16 55.7	145 48
Green I., [and rfs. 3m.], 90f.	16 46	146 0
Port Douglas, lt. Rev. 82f.	16 29.3	145 29
Low Is., lt. R 65f.	16 23	145 35
Snapper I., [1½m.], w₀, SE pt., 350f.	16 17.7	145 31
Archer Pt., lt. F 220f.	15 36	145 2
C. Tribulation	16 4.4	145 30
Endeavour R., Cooktown Pilot Station, lt. F 570f.	15 27.5	145 15 2
Turtle rf., [3m.], r̄, N pt.	15 24	145 27
C. Bedford, 818f., ⊥, (shl. 1m.)	15 16 5	145 23
C. Flattery, 2 pks., 863f., pt.	14 59	145 23
Lizard I., [3m.], 1167f.	14 40	145 30
Eagle I., [1m.], *l*, ⚘, (shl. S-d.)	14 42	145 24.7
Lookout Pt.	14 50	145 15.7
Coles' Is., *l*, ✱, NE ext.	14 33	144 57
Howick's grp., $\frac{6}{18}$, SE sum.	14 32.4	145 1.5
Noble I., [1m.], rky., *h*	14 30.5	144 48.5
C. Bowen	14 31	144 42 5
Pt. Barrow, rky	14 22.5	144 42

MARITIME POSITIONS.

(111)	Places	Lat. S	Lon. E
N.E. Coast of Queensland	C. Melville, (shl. ?– 2½m.) ...	14° 10′	144° 33′·5
	Pipon Is., [2m.], *l*, ‡, N pt....	14 6·5	144 34
	Clack's I., small, *h*, rk., ⊥ ...	14 4·7	144 17·5
	Flinders grp., ? 2 l., 994f., N pt. C. Flinders	14 8	144 16·2
	Jane's Tableland, abt. 1000f.	14 29	144 10
	A dry sand, [1½m.]	14 8	144 2·5
	Low Woody I., [1m.]	13 40	143 43
	C. Sidmouth	13 25	143 37·2
	C. Direction, rf. 2m.	12 51	143 34
	C. Weymouth, Restoration I., ⊥, pk. 446f., W pt., *l*, ✱, †	12 37·5	143 27·5
	Fair Cape, rf. 2m.	12 25	143 17
	Forbes Is. sum. 340f.	12 16	143 24
	C. Grenville, E pt.	11 57·5	143 13·2
	Conical Hill	11 50·3	143 18·7
	Sir Ch. Hardy's Is., [8m.], ww_0, N one, 320f.	11 54·7	143 28·5
	Cockburn rf., Cockburn I., 300f.	11 50·3	143 18·7
	Bird Is., *l*, ‡, West I.	11 46	143 4·7
	Orfordness, Pudding-pan Hill, 403f.	11 19·7	142 48
	Cairncross I., ‡, 93f.	11 14·5	142 55
	Bushy I.	11 15·5	142 53·5
	Arnold I., ✱, 30f.	11 0·3	142 59·2
	Shadwell Pk, 245f.	11 0	142 44
	Z Reef, beacon	12 49·3	142 43
	Grt. Albany Is., Ulriea Pt. ...	10 45	142 37·2
	Mount Adolphus Is., Mt. Adolphus, 548f.	10 38	142 39·2
	North Brother	10 42·3	142 40
	N. extr. of Australia. C. York I., small, rky., 283f., ⊥ ...	10 41·2	142 31·5
	C. York, Sextant bk.	**10 41·7**	**142 32·7**
	Barrier Reefs.		
Barrier Reefs	S limit of Grt. Barrier rfs., Swain's rfs.	22 23·2	152 36
	Hixson Cay	22 20	152 41
	NE lim	21 5	152 52
	Flinders. rfs., S extr.	17 55	148 31
	Herald's Surprise	17 20	148 28
	Endeavour opening	15 42	145 48·5
	Lark Pass	15 7	145 45
	First Three mile opening, N pt. of rf., T	13 26·5	144 0
	Second Three-mile opening, (rf. in mid.), pt. to E-d., T	13 5	143 54
	Cook entr., (1770), Providential Chan.	12 39	143 49
	Southern, small, [1m.]	12 40·5	143 50·5
	Northern, small, [1m.]	12 25	143 48
	Black rks., N pt.	12 12·5	143 55
	Yule's rf., [1 l.], E edge, T ...	11 58	143 58
	Nimrod's entr., [3c.]	12 6	143 47
	Stead's entr., [⅓m.]	11 55	143 49
	Grt. Detached rf., NS 4 l., E extr.	11 44·5	144 6
	— South-east pt.	11 51	144 5
	Raine I., ? 1½m., (entrance), ⌐, w_0, beac. 60f.	11 36	144 1·2
	Pandora entr., [2m.]	11 26·5	144 0
	Olinda entr.	11 14·5	144 5
	Yules' opening, 11, [1m.], (current I)	10 23	143 55·5

(112)	Places	Lat. S	Lon. E
	Fly entrance, ?, [½m.]	10° 1′	144° 3′
	Cumberland entrance	9 52·5	144 8
	Murray Is., [4m.], grt. one, †, pk. 700f.	9 55	144 1
	Flinders' entr., ? 4m., S pt., T	9 35	144 10
	Islands and Shoals Eastward of Australia.		
	Ball's Pyramid, 1810f.	31 45	159 15·2
	Lord Howe I., 2834f., w′	31 31·5	159 5
	Seringapatam and Elizabeth rf, mid.	29 56	159 4
	Middleton rf	29 28	159 4
	A rock	24 0	160 15
	Capel bk., 52	25 15	159 18
	Ferriers' bk., 17, $\beta\beta_0$	23 23	155 32
	Cato bk., β	23 14	155 33
Islands and Shoals Eastward of Australia	Wreck rf., (Porpoise and Cato, 1803), EW 7 l, Eastern extremity, Bird Island, ✱	22 10	155 28
	Sir James Saumarez bks., [3 leagues], SW Cay	21 51	153 30
	Frederick, shoal, (ship, 1812)	21 1	154 23
	Kenn rf., ? 9 miles, low, T, δ	21 15	155 49
	Booby shoal, NW extreme ...	20 57	158 31
	Mid. Bellona	21 24·3	158 52
	Bellona shl., NW	20 47·7	158 27·2
	Bellona shl., S	21 47·3	159 34
	Ball's rks.	21 0	160 36
	Bampton shl., [17 leagues], South-West part. Avon Islands, 2, [2 miles], *l*, ‡	19 33	158 16
	Bampton I., 17f.	19 8	158 30
	Reward I, 20f.	19 13·5	158 55·7
	Mellish Cays, [4 l.], mid.	17 25	155 53
	Lihou shoal, [15 l.], E lim.?	17 10	152 12
	Tergrosse Islets, 2, rfs., W pt.	17 43	150 42
	Coringa shl., Id. 10f., rfs., Chilcott I.	16 50	149 57
	Bougainville shls., 2, δ, NS 6 l., N pt.?	15 31	147 7
	Osprey shl., ? 10m., S pt. ...	13 50	146 34
	Torres Straits.		
	Possession I., ? 3m., rky., $✱_0$, ww_0, centre	10 5	142 19
	Double I., [4m.], 218f., N sum.	10 27	142 26
Prince of Wales Is.	Prince of Wales' I., 5 l., Heath Pt.	10 35·7	142 11
	— S pt., or C. Cornwall	10 46	142 10
	Wallis Is., shl., N one, 60f. ...	10 51	142 1
	Thursday I., Vivien Pt., fl. st.	10 35	142 12
	Goode I., lt. F 345ft	10 33·7	142 8·2
	Booby I., [¼m.], 30f., ✱, ⌐, r, ww_0, "Post Office" ⊕	10 36	141 54·0
	Proudfoot shl., ?, lt. ves. occ.	10 32	141 22
	Eastern Fields, [7 l.], E end, ✱	10 5	145 45
	Boot rf., NS 4 l., (shls. SE-d and SW-d), N pt....	9 58	144 40
	Portlock rf., N limit	9 28	144 53

MARITIME POSITIONS

(113) Places	Lat. S	Lon. E
Torres Straits, Eastern Entrances		
East Cay	9° 24′	144° 12′
Anchor Cay, (S lim. of Bligh's entr.)	9 22	144 6
Bramble Cay, sandbk., 12f., ~, (Blk. rks. $\frac{\mid}{4}$ 3m.)	9 8	143 51
Darnley I., or Erooh, (at W edge of rfs., $\frac{4}{4}$ 11m.), ww_o, $P_{\prime}$, hill 610f.	9 35·3	143 45
Nepean I.	9 34	143 39
Stephen's I., *l*, ⚓	9 31	143 32
Pearce Cay	9 30	143 16
Dalrymple I.	9 37	143 18
Rennel I., village	9 46	143 15
Yorke Is., 2, W Id., village	9 45	143 25
Arden I.	9 53	143 9
Aureed I., village	9 58	143 16·5
Half-way I. and rfs., $\frac{2}{2}$ 4m., NW pt.	10 6	143 17
Cocoa-Nut I., 2, [4m.], E pt.	10 4	143 6·5
Dove I.	10 0	143 1
Dungeness rf., S pt.	10 4·5	142 56·5
Dungeness I., EW 4m., W pt.	9 52	142 53
Warrior I., [$1\frac{1}{2}$m.], at S pt. of Warrior rf.	9 48	142 57
Turtle-backed I., 268f., †	9 54	142 45·5
Long I., $\frac{6}{6}$ 4m., ✻, rfs. E-d, W pt.	10 2	142 48·7
Gabba I., Brothers, hills, *h*	9 45	142 37
Poll rk.	10 16	142 49
Harvey rks.	10 19	142 40
Mt. Ernest, 807f.	10 15·5	142 28·2
North Possession I.	10 5·2	142 19
Banks I., Mt. Augustus, 1310f.	10 10	142 19
Mulgrave I., peak, 686f.	10 8	142 8·2
Duncan Is., Whale I., N pk.	10 15·5	142 3·7
Jervis I., [2 l.], 525f.	9 58	142 10
Cook Reef	10 23	141 33
Alert Reef, [$\frac{1}{4}$m.]	9 52	140 38
NEW ZEALAND.		
West Coast, Middle Island		
Farewell Spit, bush end pt., lt. Rev. 120f.	40 33·3	173 2
C. Farewell	40 30	172 42
Mount Olympus, 5400f.	40 52	172 35
Rocks Pt.	40 58	172 4·5
C. Foulwind, lt. R 190f.	41 45·5	171 28·7
Grey R., lts. F.	42 26	171 13
Hokitika R., lt. F 122f.	42 42	170 59
Abut Hd., extr.	43 7	170 17
Mt. Cook, 13,349f.	43 33·5	170 12·2
Cascade Pt., N extr.	44 0	168 24
Milford So., Freshwater basin	44 40·3	167 55·7
Pembroke Pk., 6710f.*	44 35	167 54
George Sound, Anchorage Cove, N side	44 55·3	167 26·7
Thompson Sound, Deas Cove, hd.	45 11·7	166 58·2
Breaksea Id., NE pt.	45 34·7	166 38·7
Five Fingers Pt., Dusky B.	45 44·2	166 28

(114) Places	Lat. S	Lon. E
West Cape	45° 54′	166° 26′
Chalky I., (S entr. of Dark Cloud inlet), N pt.	45 59	166 35·7
Puysegur Pt., lt. Fl. 180f.	46 10	166 38
Sandhill Pt.	46 16	167 22
Solander Id., [1m.], 1100f.	46 36	166 55
Stewart I.		
Black rk. Pt.	46 41·5	167 53·7
Mt Anglem 3200f.	46 45	167 57
Codfish I., $\frac{4}{4}$ 3m., NW rocks	46 46	167 37·7
Ernest I., W head of Mason B	46 57	167 42
Wedge I., $\frac{2}{2}$ 1m., cent.	47 13·5	167 21·5
SW Cape	47 17	167 30
Port Pegasus, cove abreast Anchorage island	47 11·7	167 41·7
Wreck rf., [$\frac{1}{2}$m.]	47 6	168 18
Port Adventure, Entrance I., E pt.	47 4·7	168 14·2
Paterson Inlet, Glory Cove, hd.	46 58·5	168 10·7
North Trap, $\frac{6}{5}$ $2\frac{1}{2}$m., 5f., E pt.	47 22·2	166 55·2
South Trap, rf. NS 2m., S pt	47 33	167 53
Snares, [1 l.], 470f., ~, W Id.	48 7	166 29
Middle I., South and East Coasts		
Centre I., lt. F 265f.	46 28	167 52
Awarua, Bluff Hr., Starling Pt., lt. F 30f.	46 37	168 23
Ruapuke I. (group $\frac{6}{6}$ 10m.), N pt.	46 45	168 33
Slope Pt.	46 41	169 3
Nuggett Pt., lt. F 250f.	46 27·2	169 51
Saddle Hill	45 55	170 22
C. Saunders, lt. Rev. 210f.	45 53	170 46
Taeri I., [$\frac{1}{4}$m.], mo. of T riv	46 4	170 15
Otago Harb., Taiaoa Hd., lt. F	45 47	170 45
Whalers' Home Pt., Merangi, lt. F 170f.	45 24	170 53
C. Wanbrow, Oamaru, lt. F	45 7	171 1
Waitangi R., mo.	44 55	171 12
Timaru, lt. F 85f.	44 23	171 18
Banks' Peninsula, Akaroa Harb., ⊞, W head, lt. Fl. 270f.	43 54	173 0
— East point	43 46	173 9
Port Cooper, ⊞, Lytt. Cust. ho.	43 36·7	172 44·2
Christchurch*	43 32	172 37
Table Id.	43 4	173 5
Hurunui R.*	42 55	173 18
Kaikora Penins., E pt.	42 26	173 44
Kaikora Range, sum. 9700f.*	42 1	173 41
Ben More, 4360f.*	41 55	174 2
C. Campbell, lt. R 155f.	41 44	174 18·2
Wairau R., lt. F 38f.	41 30	174 5
Port Underwood, E head	41 21	174 8
Middle I., N. Coast		
Brothers, lt. Fl. 258f.	41 6	174 27
C. Jackson	41 0	174 20
Stephen's I., [1m.]	40 40	174 1
D'Urville I., Port Hardy, E arm, Wooding Pt.	40 46·6	173 55
— Greville Harb., S head	40 50	173 48
Current Basin, Cross Pt.	40 56·3	173 52·2
Nelson, lt. F 60f.	41 15·6	173 17
Astrolabe rd., Adele I., NE pt.	40 58·9	173 5·2
Separation Pt.	40 47	173 2
Clifton, anchorage	40 50	172 52

* *Positions marked thus are provisional.*

MARITIME POSITIONS

(115) Places	Lat. S	Lon. E
North I., East Coast		
Kapiti I., ✸ 5m., sum. 1780f.	40°52′	174°55
Mana I., (off Porirua Harb.), ✸ 1½m., sum. NW pt.	41 5·8	174 48
C. Terawiti, extr.	41 17·2	174 38·2
Port Nicholson, ⊞, East or Pencarrow Hd., lt. F 420f.	41 22·0	174 52·0
Wellington, Pipitea Pt.	41 16·5	174 47
— Mount Cook, Observatory	41 18	174 45·7
Taourakira Hd., extr.	41 26	174 56
C. Palliser, extr.	41 37·5	175 17
Flat Rock, extr.	41 15	175 58·5
Castle Pt., extr.	40 54·5	176 14·2
C. Turnagain, E extr.	40 29·5	176 38·5
C. Kidnappers, extr.	39 38	177 8
Ahuriri Road (Napier) Bluff lt. F 160f.	39 28·7	176 57
Mahia Peninsula, Table Cape	39 6	178 1
Portland I., S extr., lt. R 300f	39 18	177 53
Poverty B., Gisborne lt. F.	38 41	178 3
Ariel rks., centre, δ	38 44	178 18·5
Gable end Foreland, white gab.	38 32	178 18
Tolago B., Motu Heka islet...*	38 20·8	178 21·2
Open B., N pt.	37 58	178 23
Mt. Hikurangi, 5535f.*	37 53	178 3
East Cape islet, 420f.	37 40	178 36
New Zealand		
Matakawa Pt.	37 32	178 21
C. Runaway, extr.	37 31	178 1
Waikaua Pt.*	37 38	177 46
Mt. Edgecumbe, E sum. 2575f.	38 6	176 45
White I., 863f.	37 30	177 12
Tauranga Harb., ⊞. Mt. Monganui, entr., E side	37 36·4	176 11
Motiti I., ✸ 3m., N pt.	37 35	176 25
Mayor I., [2m.], 1110f.	37 16	176 15
Tairua R.	36 59	175 54
Mercury B., Oyster R. mo.	36 49	175 48
Alderman Is., [4m.]. E or outer	36 56	176 7
Red Mercury I., [1⅓m.]. E pt.	36 37	175 59
Great Mercury I., [illegible] 4m., N pt.	36 34	175 49
Richard's rk.	36 35	175 58
Cuvier I., [1¼m.], sum	36 26	175 48
Channel I. (*Takoupo*), 270f.	36 26	175 21
C. Colville	36 28	175 22
North I., North-East Coast		
Coromandel Harbour, ⊞. Juhuia I.	36 48·6	175 25·5
Riv. Thames, Grahamstown, lt. F	37 8	175 33
Pauhenehe spit, lt. F 50f.	36 54	175 12
Bean rocks, lt. F 50f.	36 50	174 52
Auckland, ⊞, Dépôt Pt. ... ⊕	36 50·1	174 49·2
Tiri Tiri I., lt. F 300f. on SE pt.	36 38	174 56
Kawau B., Fish Pt., E entr.	36 27·0	174 48·5
Great Barrier I., 2330, [illegible] 71., S pt C. Barrier	36 22	175 33
— Port FitzRoy, W pt. of E side	36 12·0	175 22·5
— Wellington Hd.	36 10	175 18
— Id. off N end, N or Aiguilles Pt.	36 2	175 27
Horn rk.	36 15	175 13
Simpson rk.	36 1	175 9
Mokou Hinou Is., ✸ 1½m., lt. F 385f.	35 57	175 9
Rodney Pt.	36 17	174 51
Bream Tail	36 3	174 37
Moro Tiri Is., EW 5m., E pt.	35 54	174 49

(116) Places	Lat. S	Lon. E
N.E. Coast		
C. Tewara, or Bream Hd.	35°52′	174°37′
Wangari Harb., ⊞, Passage I.	35 51	174 31·5
Tutukaka Harb., N head	35 38	174 34·0
Poor Knights' Is., N one, 630f.	35 29	174 45
Wangararu Harb., Grove Pt.	35 23·3	174 22·2
Waimangaroa pt., lt. F. on wharf*	35 19	174 8
C. Brett, (W hd. of B. of Is)	35 10	174 21
Port Russel, wharf, lt. F 20f.	35 16	174 8
C. Wiwiki *	35 9	174 10·7
Cavalli Is., great, NE extr	35 0	173 58
Stephenson I., NW pt.	34 58	173 47·5
Wangaroa Harb., Peach I.	35 1·7	175 46·7
Flat Hd., (E. hd. of Doubtless B.)*	34 55	173 35
Mongonui Harb., White's Pt.	35 0·3	173 33·5
C. Karakara, extr.	34 47·3	173 25·2
Parenga-reoga Harb., coal pt.	34 30·7	173 1·7
North Cape, islet	34 25	173 4·5
C. Reinga *	34 26	172 41
C. Maria Van Diemen, islet lt. Rev. 330f.	34 28·5	172 38·7
Three Kings, 995f., NE one, NE pt.	34 6·3	172 9·7
New Zealand, North I. W. Coast		
Reef Pt., W. ent. of Ahaipara B.	35 11	173 5
Herekino, S pt.	35 18·2	173 11
Hokianga R., entr. fl. st.	35 32·1	173 23
Monganui Bluff, 2040f., bluff	35 46·3	173 34·7
Kaipara Harb., ⊞, shls. 1 l. out, N. entr. lt. Fl 278f.	36 24·3	174 7
Manukau Harb., ⊞, South Hd., lt. F 385f.	37 3	174 33·2
Waikato R., Maratai Vill.	37 24·3	174 47·2
Whaingaroa Harb., S entr. pt.	37 46·5	174 53·2
Karehoa Mt., 2370f.*	37 50	174 51
Gannet Id., summit, 70f.	37 57	174 35
Aotea Harb., entr., N hd.	37 59	174 49
Ka Whia Harb., ⊞. S hd.	38 4·9	174 49
Albatross Pt., N extr.	38 6·2	174 43·5
Terua Pt.	38 23	174 40
Mokau R., entr.	38 42·5	174 38·7
Raleigh, lt. F.	39 0	174 15
New Plymouth, lt. F 100f.	39 3·6	174 2
S.E. Coast		
C. Egmont, extr., lt. F 103f.	39 17	173 46
Mt. Egmont, 8270f.	39 18	174 5
Patea R., Carlyle, lt. F 130f.	39 47	174 31
Waitotara Pt.*	39 52	174 44
R. Wanganui, N or Castle cliff, lt. F 65f.	39 57	175 1
R. Manawatu, N lt. F 44f.	40 27·2	175 14·7

* *Positions marked thus are provisional.*

MARITIME POSITIONS

(117) Places	Lat. S	Lon.
SOUTH PACIFIC OCEAN.		
Auckland Islands.		East
Bishop and Clerk	55° 18′	158° 56′
Macquarrie I., NS 12 l., N pt.	54 40	158 56
Judge and Clerk	54 19	159 10
Campbell I. [3 l.], 1867f., South harb., Shoal pt.	52 33·4	169 8·7
Auckland Is., NS 8 l., S.C. 2000f.	50 56	166 4
West extreme	50 50	165 57
Disappointment I., [1 l.]	50 37	166 0
C. Bennet	50 51	166 15
Sarah's Bosom, Terror Cove	50 32·5	166 12·5
Bristow rk, δ	50 26	166 18
Antipodes I. Depôt, 1320f.	49 39	178 50
Bounty Is., EW 3½m., 290f.	47 43	179 0
Chatham Islands.		West
Chatham Is, Whare-Kauri, 4|4 20 l., S. isl., Tarakoikoia Pyramid, 566f.	44 20	176 17
— Rangiauria, Pitt I., 2|2 7m, ✝, Moutapu pt. (rks. 2m.), 791f.	44 14	176 11
— Great I., 6|6 13 l., S pt. Pt. Evêque	44 8·5	176 35
— Port Waitangi, w, Pt. Hanson	43 57	176 31
— E extr., Wakuru I. (rf. 2m.), E pt.	43 44	176 10
— Bertier rk., 150f., [2m.], W pt.	43 58	175 48
— North-west reef, extr. pt.	43 31	176 53
Islands off Coast of South America.		
Juan Fernandez I., 3000f., 6|6 4 l., Cumberland B. Fort	33 37·6	78 53
— S. pt., Sta. Clara I., EW 2m.	33 45	79 2
Masafuera I., 6023f.	33 45·5	80 45
St. Ambrose I., 1512f., W rock (St. Felix, 472f.)	26 21	79 59
Sala y Gomez, rks. [½m.], vis. 15m.	26 27·7	105 28
Easter I., 6|6 4 l., 1767f., Perouse Pt., Cook's Bay	27 10	109 26
Ducie I., 4|4 2m., 14f., NE pt.	24 40·3	124 48
Elizabeth I., 2|2 5m., NE pt.	24 21·3	128 19
Pitcairn I., 6|6 2m., 1000f., Adamstown	25 3·6	130 8
Oeno I. [2½m.], N pt.	24 1·3	130 41
Low Archipelago.		
Disappointment Is., 2, Wytoohe I., SE pt. ⊖	14 12	141 12
— *Tetopoto*, Otoohoo I. ⊖	14 6	141 24
Clermont Tonnerre I. (*Reao*), or Minerva, 6|6 10m., SE pt.	18 34	136 20

(118) Places	Lat. S	Lon. W
Serle I. (*Pukaruha*), 4|4 7m., SE pt.	18° 22′	136° 58′
Narcissus, or Clerke I. (*Tatakoto*), E end ○	17 18	138 19
Predpriatie I. (*Fakaina*), 6|6 4m., centre	15 58	140 8
Araktchceff I. (*Angatu*), 4|4 5m. centre	15 51	140 50
Crescent I. (*Timoe*), 2|2 3m., S pt.	23 20·5	134 29
Portland reef	23 41	134 30
Gambier Is. (*Manga Reva*), 4|4 6 l., rfs., ⊞, w, Flgstf. 1315f.	23 7·5	135 0·2?
Lord Hood I. (*Marutea*) [4 l.], W pt.	21 31	135 38
Maria I. (*Moerenhut*) [4m.]	22 0	136 12
Actæon Is., 3 [5 l.] (*Maturei Varao, Melbourne I.*)	21 25	136 25
Carysfort I. (*Tureia, Papakena*), 2|2 7m., NE pt.	20 45	138 30
Barrow I. (*Vana Vana*), N pt.	20 45	139 10
Marooe or Cadmus I.	23 8	137 8
Cockburn I. (*Fangataufa*), [4m.], lag. NE pt.	22 12	138 42
Osnaburgh, or Matilda I. (*Mururoa*), 6|6 5 l., ✝, ✝ₒ, E pt.	21 50	138 47
Bligh's Lagoon I. (*Tematangi*), 2|2 2 l., Ꝉₒ, N pt.	21 38	140 40
Cook Lagoon I. (*Vahitahi*), 6|6 3m., ✝, P′, N pt.	18 42	138 50
Thrum Cap (*Akiaki*) [¾m.], NW pt.	18 30	139 14
Bow I. (*Hoa*), 2|2 8 l., ⊞, w̄, lag. Morai on E side of entr.	18 3·6	140 59·2?
— South pt.	18 16	140 41
Moller I. (*Amanu*), 4|4 5 l., ✝ ✝, P, N pt.	17 40	140 39
Resolution I., 2 Is. (*Tauerie*), [4m.], S pt.	17 23	141 30
Good Hope I. (*Rekareka*) [2 l.], S pt.	16 51	141 55
Barclay de Tolly I. (*Raroia*), 2|2 6 l., S pt.	16 13	142 31
Wolkonsky I. (*Takume*), 2|2 13m., lag. ‖ₒ, N pt. ✝ ✝	15 44	142 9
Whitsunday I. (*Pinaki*) [1½m.], NW pt.	19 24	138 43
Queen Charlotte I. (*Nukutavake*), EW 3m., ⊥, ✝ₒ, E pt.	19 17	138 49
Egmont I. (*Vairaatea, Pukarunga*), 6|6 4 m., T, ✝, ✝, Lₒ, N pt.	19 18	139 18
Byam Martin I. (*Ahunui*), [4m.], lag., b, N pt.	19 37	140 25
Gloucester I. (*Paraoa*), EW 3m., NE pt.	19 8	140 40
Cumberland I. (*Manuhangi*), 6|6 2½m. SE pt.	19 12	141 16
Lasting I., or Pr. Wm. Henry (*Nengo-Nengo*), EW 5m., NE pt.	18 46	141 45

MARITIME POSITIONS

	(119) Places	Lat. S	Lon. W
Low Archipelago	D. of Gloucester Is., 2, E, or Margaret I. (*Nuku-tipipi*) .... ⊖	20°42′	143° 5′
Low Archipelago	Anu Anurunga, W Id. ...... ⊖	20 38	143 19
Low Archipelago	St. Paul's I. (*Kerekere-tae*), $\frac{6}{5}$ 4 l., N pt. ...... ○	19 52	145 0
Low Archipelago	Two Groups I., $\frac{2}{12}$ 8 l. (*Maro-kau* and *Ravahere*), S pt...	18 18	142 12
Low Archipelago	Melville I. (*Hikueru*), NW pt.	17 35	142 41
Low Archipelago	Tekokoto [3m.], E. pt.........	17 20	142 37
Low Archipelago	Furneaux I. (*Marutea*), EW 7 l., W pt.	16 54	143 20
Low Archipelago	Nihiru I., NS 3 l., N pt.........	16 41	142 53
Low Archipelago	Holt, or Yermaloff I. (*Taenga*), EW 5 l., Pass.........	16 20	143 11
Low Archipelago	Philip's I., or Koutousoff (*Makemo*), $\frac{6}{5}$ 11 l., W pt.	16 26	143 58
Low Archipelago	Sacken I. (*Katiu*), W pt.	16 22	144 28
Low Archipelago	Romanzoff I. (*Tikei*), [3m.] ...	14 56	144 33
Low Archipelago	K. George's I., Tiokea, Pyramid	14 27	145 0
Low Archipelago	— Ura I., $\frac{\|2}{2}$ 4 l., S pt.	14 44	145 14
Low Archipelago	Waterlandt, or Wilson's I (*Manihi*), $\frac{\|5}{6}$ 4 l., E pt. ...	14 23	145 50
Low Archipelago	Peacock I. (*Ahui*), $\frac{\|5}{6}$ 4 l., W pt.	14 33	146 24
Low Archipelago	Bird I. (*Reitoru*), N pt.........	17 48	143 7
Low Archipelago	Croker I. (*Haraiki*), N pt. ...	17 29	143 31
Low Archipelago	Adventure I. (*Motutunga*), NW Pass.....................	17 3	144 25
Low Archipelago	Raeffsky I., or Seagull grp., S & W one, Clute I. (*Hiti*)	16 42	141 9
Low Archipelago	Tehitchagoff I. (*Tahanea*), NW pt.	16 46	144 58
Low Archipelago	Miloradovitch I. (*Faaiti*), NW pt.	16 42	145 22
Low Archipelago	Wittgenstein I. (*Fakarava*), $\frac{4}{5}$ 10 l., ⚓ ⚓, ↕ SW Rotoava Pyramid	16 2	145 36
Low Archipelago	Greig I. (*Niau*), [5m.], N. pt.	16 7	146 23
Low Archipelago	Chain I. (*Anaa*), Tuuhora pass.	17 20	145 30
Low Archipelago	Raraka, EW 5 l., entrance ...	16 4	144 59
Low Archipelago	Kauehi I., $\frac{2}{12}$ 14m., S pt.	15 56	145 11
Low Archipelago	Tiaro King's I., N pt.	15 46	144 37
Low Archipelago	Carlshoff I. (*Aratika*), W pt. ○	15 33	145 34
Low Archipelago	Rurick Is. (*Arutua*), $\frac{\|2}{2}$ S pt.	15 26	146 44
Low Archipelago	Hagemeister I. (*Apataki*), NE pt.........................	15 18	146 15
Low Archipelago	Elizabeth I. (*Toau*), E pt., Otuni	15 55	145 50
Low Archipelago	Aura I. (*Kaukura*), W pt. ...	15 40	146 51
Low Archipelago	Dean, or Vliegen I. (*Nairsa*), $\frac{6}{5}$ 15 l., N Avatika, W pt.	14 46	147 50
Low Archipelago	Krusenstern I. (*Tikehau*), Tuhciava pass.	14 58	148 14
Low Archipelago	Aurora I. (*Makatea*), 230f. N pt..............................	15 48	148 13
Low Archipelago	Lazareff I. (*Mataiwa, Malivi*, [5m.], ⚓ ⚓, P, W pt.	14 54	148 40
	Society Islands.		
	Maitea I., $\frac{6}{5}$ 7 m., P, 1597f...	17 53	148 5
	OTAHEITE I. (*Tahiti*), $\frac{4}{2}$ 12 l., PT. VENUS, lt. F 82f.	17 29·2	149 29
	— Summit, Orohena, 7321f....	17 37	149 28

	(120) Places	Lat. S	Lon. W
Society Is.	Otaheite I., Papeete Harb., ⊞, w Motu-uta Is., lts. F	17°31′6	149°34′
Society Is.	Murea, or Emeo, Mt. Tohivea, perforated pk., 3975f.	17 32·5	149 48·7
Society Is.	Tetuaroa I., EW 5m., SE pt.	17 2	149 32
Society Is.	Tapamanu I., or Sir C. Saunders (*Mauiti*), pk.	17 38·7	150 37
Society Is.	Huaheine I., 2231f. Owharree harb.	16 42·5	151 1·5
Society Is.	Ulietea, or Raiatea I., NS 14m., Uturoa harb., ⊞′	16 43	151 26
Society Is.	Regent pt., or Taháa, Tautu I.	16 33·7	151 30·5
Society Is.	Bola bola I., NS 8m., sum. ...	16 30	151 45
Society Is.	— Oteavanua, ⊞, *w*′, *r*, ho. ...	16 30	151 42
Society Is.	Tubai I., [5m.], N pt.?	16 11	151 48
Society Is.	Marua, or Maupiti I., 800f....	16 26·5	152 12
Society Is.	Howe I., Mopelia (*Mopihá*)...	16 52	154 0
Society Is.	Scilly Is., [2 l.], *l*, rfs., ⚓, P ⊖	16 31	154 43
Society Is.	Bellingshausen I.	15 48	154 25
	Marquesas.		
Marquesas	Marquesas, w, r, b, E extr., Ariane rk., 13f.	10 21	138 25
Marquesas	Magdalena I. (*Fatu-hiva*), NS 8m., 3150f., Hanavave H^r	10 27·1	138 39
Marquesas	St. Pedro I. (*Motane*), 1640f., SE pt. rk. ...... ○	10 1	138 48
Marquesas	Sta. Christina (*Tau-ata*), ab. 3280f., Resolution B., E side	9 56·3	139 7
Marquesas	Dominica I., 3520f. (*Hiva-Oa*), Perigot B. (*Paumau*)	9 44·8	138 52·7
Marquesas	Hood I. (*Fatuhuku*), [4m.], ab. 1180f., ⊥, ✱, P......	9 26·5	138 55
Marquesas	Washington I. (*Ua-huka*), [3 l.], ab. 2805f., Hannay B. (*Motu-Haane*)	8 56	139 32
Marquesas	Adam I. (*Ua-pa*), 4042f., Hakahe-tau B.	9 21	140 4·2
Marquesas	Nukahiva, [6 l.], ab. 3800f., head of Anna Maria B....	8 55·3	140 4·7
Marquesas	Hergests rks. (*Motu-iti*), 130f. .... ⊖	8 41·7	140 36
Marquesas	Masse (*Eiao*), ab. 2000f., pk. ○	8 1	140 40·5
Marquesas	Coral rf., [& shl. 2 l.] ...... ○	7 53	140 22
	Islands North-west of Low Archipelago.		
Islands N.W. of Low Archipelago	Starbuck I., [1 l.?], ⚓, *β*, 15f., W. pt.	5 37	155 56
Islands N.W. of Low Archipelago	Malden I., [3 l.], w, ⚓′, [⚓], 30f., W pt. Settlement ...	4 3	155 1
Islands N.W. of Low Archipelago	Jarvis I., 40f. [2m.], *l*, ✱, ⚓, *δ*..............................	0 23	159 54
Islands N.W. of Low Archipelago	Caroline Is., numerous, small, 18f. *l*, ‖°, ⚓, T, South island Settlement	10 0	150 14·5
Islands N.W. of Low Archipelago	Vostok I., [½m.], ab. 80f., rfs., ⚓, lag., ⚓, Boat pass.	10 6	152 23
Islands N.W. of Low Archipelago	Flint I., 50f. *l*, ⚓ Settlement...	11 26	151 48
Islands N.W. of Low Archipelago	Suwarrow Is., 4, small, P, 15f.	13 13	163 13
Islands N.W. of Low Archipelago	Penrhyn I., $\frac{2}{12}$ 4 l., *l*, lag. ‖°, ⚓ ⚓, P, 50f., W pass.	9 0	158 35

MARITIME POSITIONS

(121)	Places	Lat. S	Lon. W
	Reirson I., 60f. (*Rokahanga*), Church [2m.], *l*, ✝, P ...	10° 2'	161° 55
	Humphrey I., 65f., Church (*Monahiki*) ...	10 23·5	160 59
	Bernardo, or Daoger Is., 3, small, δ 125f., Puka Puka	10 52·8	165 51·5
	Tema Reef, δ ...	11 7	165 35
	Nassau, or Ranger I.?, small, *l*, w, b, P_o, 70f. ...	11 33·3	165 27
	Union Islands.		
Union Group	Gente Hermosa, 20f. [1½m.], or Swain's I., ✝ ✝, T, ...	11 10	170 52
Union Group	Duke of Clarence I., (*Nukunono*), NS 7m., lag. $\|_o$, ✝ ✝, SE I. ...	9 13	171 44·7
Union Group	Duke of York I. (*Oatafu*). 4m., lag. $\|_o$, ✝ ✝, P', S I., trees ...	8 39·7	172 28
Union Group	Bowditch I., 80f. (*Fakaafo*). 7m., lag. $\|_o$, ✝ ✝, w S pt. ...	9 28	171 9·2
	Phœnix Islands.		
Phœnix Islands	Mary or Canton I., 15f., West Entrance ...	2 8·9	171 42·5
Phœnix Islands	Hull Is., 5, EW 5m., *l*, δ, lag., ✝ ✝, w, W pt. ...	4 30	172 13·2
Phœnix Islands	Sidney I., 15f., W pt., *l*, w_o ...	4 27·4	171 16
Phœnix Islands	Phœnix [2m.], 20f., *l*, sand, T, North point ...	3 42·5	170 42·5
Phœnix Islands	Birnie I., 6f., & rfs. [2m.], δ, *l*, centre ...	3 35	171 33
Phœnix Islands	Enderbury I., 23f., 3m., ✝, Pier on W side ...	3 8·5	171 10
Phœnix Islands	Gardner, or Kemin I., 40f., *l*, lag. $\|_o$, centre ...	4 37·7	174 39·2
Phœnix Islands	M'Kean I., [¾m.], 25f.	3 35·2	174 16
	Rapa Island, &c.		
	Four Crowns, or Bass Is., 4, small, 346f. (*Morotiri*)	27 55·5	143 28·5
	Rapa, or Oparo I., 2172f., P', w, Aurei Bay, entr	27 35·7	144 17·2
	Osborne, or Nielson rf., 12f. East pt. ...	27 1·6	146 1·7
	Maria Theresa reef? ...	37 0	151 13
	L'Orne bank ...	27 42	157 44
	Haymet rocks? ...	27 11	160 13
	Tubuai or Austral Islands.		
Tubuai Is.	Vavitao I. (*Ravaivai*), NE pt.	23 50	147 40
Tubuai Is.	Tubuai I. [2 l.], vis. 10 l., ✝ T, w, b, Anchorage ...	23 22	149 36
Tubuai Is.	Ruru tú I. (*Oheteroa*), NS 4m., ab. 1300f., South pt.	22 30	151 20
Tubuai Is.	Rimitara I., [3m.], 315f. ...	22 45	152 45
Tubuai Is.	Hull I., [1 l.], ab. 66f., (β) ○	21 49	154 43

(122)	Places	Lat. S	Lon. W
	Cook Islands.		
	Mangaia I., [2 l.], ab, 650f. rfs. ...	21°55'	157°56'
	Rarotonga I., [3 l.], 2920f. r, P', NW pt. ...	21 14	159 45
	Parry, or Mauki I., 120f., [2m.]. *l*. ✝, S pt. ...	20 7	157 22
Cook Is.	Mitiéro I., 92f., NS 4m., *l*, [✝]. Tomb on W coast ...	19 49	157 43
Cook Is.	Vatiu I. (*Atiu*), 394f., [5m.], SW Peak ...	19 59	157 43
Cook Is.	Fenua iti (*Tahutea*), 50f., [1m.], *l*, ✝ ✝, W, w_o, B, centre ...	19 49	158 16
	Hervey Is., 2, (*Manuai*, S, *Auotu*, N), 60f., 2 l., $\|_o$. rfs. 3m., ✝ ✝, N I. ...	19 11	158 49
	Whytootackie I. (*Aitutaki*), [& rf. 3 l.], 360 f., N pt. ... ⊖	18 57·5	159 49
	Palmerston Is., NS 4m., $\|_o$, ✝, w_o, r, centre ...	18 3	163 10
	Beveridge, Middleton, or Nicholson shl., NS 3 l., δ, (entr.), SW pt. ...	20 2	167 49
	Savage I. (*Niue*). NS 11m., ✝ ✝, T, P, NW pt. ...	19 0	169 50
	Antiope reef ...	18 14	168 20
	Navigator Islands.		
	Rose I., 33f., and rf. 1½m., *l*, lag., ...	14 32	168 11
	Manua I., 6m., 2500f., ✝ ✝, Tau village ...	14 14·2	169 32
	Ofu I., EW 3m., ✝, West I.	14 11·5	169 39·5
	Tutuila, 9 l., Hubner B. ...	14 21	170 51·5
	— I. off N, or Coxcomb Pt., Vatia ...	14 15·8	170 41·5
	— West cape I., lt. F ...	14 21	170 52
Navigator's or Samoa Is.	— Pango-Pango harb., w, h, r, tower rk. W of entr. ...	14 17·7	170 40
Navigator's or Samoa Is.	Upolu, 16 l., 3200f., Nuulua islet off SE pt., 120f.	14 2	171 22·2
Navigator's or Samoa Is.	— Fangaloa B., Elds pt. ...	13 54·2	171 29·7
Navigator's or Samoa Is.	— Apia harb., w''', r, 2 lts. F., 13 & 197f. ...	13 49·7	171 44·5
Navigator's or Samoa Is.	— Tofua Mount, Crater, [1m.], 3200f. ...	13 51	172 55·2
Navigator's or Samoa Is.	— W extr. Manono I., 400f., [1m.], ✝, $\|_o$ E, w ...	13 50	172 4
Navigator's or Samoa Is.	— Safatu harb., Village pt. ...	13 56·5	171 47·7
Navigator's or Samoa Is.	Apolima I., [½m.], 472f., T, ✝ ✝ ...	13 49·2	172 6
Navigator's or Samoa Is.	Savaii, I., 14 l., 5400f., ✝, w, r, E pt. rf. ...	13 42·3	172 8·5
	— N pt., (Mataatu harb., W d., w, r, b) ...	13 28	172 21·2
	— South pt., Tanga ...	13 48·6	172 32
	— West pt., Felialupo ...	13 31	172 48
	Curaçoa reef ...	15 31	173 44
	Cocos, or Keppel I., 350f., rks. 6m. ... ○	15 58	173 52

MARITIME POSITIONS

(123)	Places	Lat.	Lon.
Islands and Banks west of Samoa Is.	Verrade·s, or Boscawen, (*Niua-tabōu-tabōu*), [& rks., ab. 6m.], ab. 2000f., r	South 15°52′	West 173°50
	Good Hope I. (*Niu-afu*), 550f., P, [3½m.], NW end, vill.	15 34	175 41
	Zephyr reef	16 0·3	177 6
	Wallis Is., 197f. (*Uea*), 9 ⚓, ⊞ S, w, b, r, Mua Mission	13 20·7	176 10
	Horne Is., 2, Alofa, ⚓, Pk. 1200f.	14 21·4	177 56·2
	— Fotuna, Mt. Schouten, 2500f., Sigave B.	14 16	178 10
	Bayonnaise bk., 18	12 8	179 43
	Field Bank	12 17	174 44
	Robbie Bank	11 3	176 53
	Isabella Bank	12 27	177 17
	Tuscarora Bank	11 49	178 14
	Ellice Islands.		
Ellice Islands	Sophia I. (*Nurukita*), vis. 16m.	10 46	East 179 31
	Rose Bank	11 3	179 50
	Mitchell grp, *Nukulailai*, Fangawa I.	9 22	179 50
	Ellice, 2 Is., (*Funafuti*), NS 14m., ⚓ ⚓, lag. ⚓′, b, w, N pass ⊖	8 25·3	179 7·5
	De Peyster Is., (*Nukufetau*), ⚓ 9m., ⚓, lag. entr. NW, 10 inside, S pt.	8 4	178 29
	Tracy I., (*Oaitupu*), [3m.], ⚓, S pt.	7 30	178 41
	Netherland I., (*Nui*), NS 4m., vis. 4 l., P, South I. Fantapu	7 15·7	177 10
	Lynx, or Speiden I. (*Nuitao*), small, no lagoon, Church	6 6	177 20
	Hudson I., (*Nanamana*), NS 1½m., 50f., ⚓, no lagoon	6 18	176 20
	St. Augustine I., (*Nanomea*), 2 Is., ⚓ 2 l., ⚓ ⚓, La kina I.	5 39	176 6
	Gilbert Islands.		
Gilbert Archipelago	Arorai, or Hurd I., (*Tamoa*)	2 39	176 52
	Rotcher I., (*Tamana*) ○	2 33	175 55
	Clerk I., (*Onoatoa*), N pt.	1 52	175 30
	Peru I., Francis Is., South pt.	1 27	175 59
	Nukunau, Byron Is., S pt.	1 24	176 31
	Tapu'eaca I., ⚓ 10 l., Peacock anchorage, ⚓ ⚓, (*Utiroa*), w_o, b, P	1 12	174 43
	Sydenham, (*Nonoti*), ⚓ 7 l., lag. $\|_o$, S pt. village	0 48·5	174 28
	Hopper I., (*Apamama*), ⚓ 10m., ⚓′ W, w, b_o, r_o, Sth. pass	North 0 21	173 51·2
	Henderville I. (*Aranuka*), EW 7m., S pt.	0 8	173 37·5
	Woodle I., (*Kuria*), ⚓ 8m., ⚓ ⚓, (rf. ⚓ 3m.), r_c w_c b_o, N pt. of reef	0 19	173 22

(124)	Places	Lat.	Lon.
Gilbert Archipelago	Hall I., (*Maiana*), ⚓ 9m., ⚓ W, 10, w_o, r_o, b_o, House on N pt.	North 1° 0·5	East 173° 1′
	Cook I., (*Tarawa*), ⚓ 7 l., ⚓, SW pt., Bititu	1 20·5	172 55·5
	Charlotte I. (*Apaiang*), ⚓ 6 l, lag entr. SE, T, ⚓ ⚓, Lone Tree I. (*Iku*)	1 46 3	172 57
	Mathews' I., (*Maraki*), NS 5m., lag., $\|_o$, N pt.	2 1·5	173 17
	Pitt I., 3 Is., ⚓, (*Makin*), N pt.	3 20	172 58
	Touching I., ⚓, lag, ‖ W, ı, (*Taratari*), South entr.	3 4·5	172 44 7
	Ocean I., (*Paanopa*), [4m.], vis. 8 l., ⚓, T, $⚓_o$, P ⊖	South 0 52	169 35
	Pleasant I., (*Nauru*), 100f. [5m.], ⚓, T, $⚓_o$, r, P	0 33	166 55
	Kermadec Islands, &c.		
Kermadec Is.	Raoul, or Sunday Is., 1627f. mid	29 15 5	West 177 55
	Havre rk.	31 18	178 59
	Espérance rk., small, 577f. ⊖	31 26	178 55
	Macaulay I. ⊖	30 15	178 32
	Curtis Is., 2, ab. 500f.	30 35	178 36
	N Minerva rf, N elbow	23 37	178 50
	S Minerva rf., mid.	23 56	179 5
	Wolverine shoal ○	25 30	179 4
	Pylstaart I., [1m.], 700f., T, ⚓ ⚓, P	22 20	176 12·5
	Pelorus reef 14 δ	22 51	176 25
	Friendly Islands.		
Friendly or Tonga Is.	Cattow I., small	21 30·5	174 53
	Eoa I., NS 4 l., ab. 600f., ‖ N, mid.	21 24	174 51
	Tongatábou I., ⚓ 7 l., *l*, w., r, b, P, Van Dieman pt.	21 4	175 22
	— N side, Niukalofa lt. F	21 8 0	175 11·7
	Reef, (H.M.S. North Star)	20 50	174 30
	Honga Hapai, (S & Wst. of 2 Is.), [1m.], 200f., ⚓, $⚓_o$	20 36	175 21
	Annamuka I., (*Namuka*), [1 l.], lag., *l*, ⚓, β ⊖	20 15	174 46
	Hapai Is., EW 16 l., S, or Fonua-ika	20 8	174 42
	Falcon I. volcano (now a shoal)	20 18 7	175 25
	Letouka I., ⚓ 5m., Mission Stat. NW side, ṙ	19 48 2	174 20
	Haano I., ⚓ 4m., E pt., Moui-tea	19 41	174 14
	N Id., or Ofo-langa, [1m.]	19 36	174 26
	Kao I., [1 l.], pyr., 3030f., ⊥	19 42	175 0
	Tofoa I., [5m.], ab. 1890f., ⊥	19 45	175 3
	Coral rf., (Sir E. Home)	19 2	174 44
	Latte I., [1 l. ?], ab. 1790f.	18 49	174 37
	Vavu I., (*Hafuluhu*), ⚓ 4 l., 600f., W pt., (Port Refuge to SE d. ⊞, 28, r, w_o)	18 39 0	174 37
	— Port Valdez, Sandy pt.	18 38 3	174 1
	Toku I., [2m.], 82f.	18 10	174 14
	Amargura I. (*Fanualei*), ⊥, $⚓_o$, 1230f.	18 0	174 24

MARITIME POSITIONS

(125) Fiji Is., Eastern Archipelago

Places	Lat. S	Lon. W
Fiji Islands.		
Ono Is., peak 370f.	20°40′	178°42′
— Simonoff (*Tuvuna-i-thulo*), 95f.	21 2	178 48
Beregis reef (*Vuata Ono*)	20 44	178 51
Vatoa, or Turtle I., [2m.] 209f ⚓ †, rf. SE, w. † ⊖	19 49·4	178 13
Nuku Singea rf., [2m.], 3f. rock	19 14·2	178 20·2
Ongea I., (2 Is. & rf., 4m.)	19 12·5	178 25
Fulanga I., (*Ongea Ndriki*), 300f., 5m., ⚓, 260f. passage	19 7·5	178 32
Namuka I., E pt., 260f.	18 51	178 35
Mothe I., 590f., peak	18 39	178 30
Kambara I., 470f., NS 3m., S pt.	18 9·5	178 56·5
Tavunasithi, 200f., small	18 43·5	179 5
Vanua Vatu I., [2m.], *h*, ⚓, P, 310f. peak	18 22	179 16
Tova rf., *Na Vatu*, [3m.], N pass	18 38	179 31·5
Totoya I., [6m.], 1184f., peak	18 57	179 48
Olorua I., 250f., peak	18 36·3	178 45
Thakau I., *Lekaleka* reef, [2m.], NE pt.	18 32·5	178 27·5
(Oneata Passage.)		
Oneata, 160f., I., [& rfs. EW 8m.], E islet	18 26·5	178 20·5
Lakemba I., 3m., ab. 720f., ⚓, peak	18 12·3	178 42·2
Bukatatanoa or Argo reefs, SE extreme	18 21·3	178 13·7
— North extreme	17 58	178 25·5
Reid reef, Reid haven	17 55	178 21
(Lakemba Passage, N-d. of do.)		
Naiau I., 5m., 580f.. sum.	17 58	179 2
Hawkins rf., *Thakau Lasemarawa*, rks. 3f.	17 47	178 40
Gordon rf., [2m.], *Thakau Tambu*, N pt.	17 38	178 32
Thithia, 540f., NE pass., NS 4m., ⚓ †, SW pt., (rf. W 3m.)	17 43	179 16·5
Tavutha I., 4m., S pt., (rfs.), 800f.	17 42·5	178 48
Katafanga I., 180f., small, rfs., pk.	17 31	178 42·7
Mango I., 670f., [4m.], SW lt.	17 28	179 10·5
Vatu Vara I., 1030f., NS 4m., pk.	17 25·5	179 31·5
Ythata I., 840f., [& rf. EW 5m.], Boat pass	17 14·3	179 30·7
Exploring Is., & rfs. 8 l., E reef, Nuku Thikombia Cairn, 6f.	17 12·7	178 39
— Munia, 950f. pk.	17 22·3	178 52·5
— Vanua Mbalavu, 930f., Black Swan pt.	17 9·5	179 0·2
Naitamba I., 5m., sum. 610f.	17 1	179 16
Look-out rf., EW 6m., E pt.	16 58	178 46·5
Wailangilala I., 70f., small, Ship pass	16 46	179 7

(126) Fiji Is., Western Archipelago

Places	Lat. S	Lon.
		West
Nanuku reef, *Nanuku Levu* at S extreme, 70f.	16°43′	179°26′5
Nuku-Mbasanga I., 70f., small	16 18	179 14·2
Ngele Levu rf., EW 10m., Ngele I., 60f.	16 5·3	179 8·7
Va-tauúa I., small, 90f., mid.	15 5·7	179 24
Budd reef, Thombia I., 590f., pk.	16 27·5	179 39·7
Thikombia I., (Farewell), Nst. of the Is., 3m., rfs., ‖, *Naulu Vatu*, 480f.	15 45	179 53·5
		East
Tiviuni I., 4040f., 8 l., ‖ South Cape	17 1	179 56
Rambe I., 1550f., C. Georgia	16 32·5	179 59·2
Vanua Levu I., 33 l., 2428f., E, or Undu Pt., *Na Potu*	16 6	180 6·5
— Savu Savu Pt.	16 48·7	179 18
— S extr., Vuya Pt.	17 1	178 44·2
— Yendua I., pk., 641f. W extreme	16 49	178 19
— Dana's Peak, 2428f.	16 42	178 55·5
— N extr. of rf. lining N coast, 3m. off Kia I., 780f.	16 10	179 5
Moala I., [& rfs., 4 l.], ab. 1535f., ⚓ †, (rf. 3m.), N pt. of reef	18 31	179 58·5
Matuku I., 1256f., [& rf. NS 4m.], Matuku harb.	19 10	179 45
Goro I., (*Koro*), NS 9m., 1710f., ⚓ NW, N pt.	17 14	179 26
Horse-shoe rf., (*Thackaumomo*), [1m.], δ, N pt.	17 38	179 17
Nairai I., NS 4m., (rfs. 4m.), Needle Pk., 1078f.	17 47·5	179 25
Ngau I., pk., 2345f. EW 8m., (rfs. S, W)	18 0	179 17·2
Mumbolithe rf., small, S pt.	18 14·2	179 19
Mbatiki I., (*Dareta Naka Savu*), [1 l.], rf.	17 46	179 9
Wakaia I., NS 4m., 595f., E pt.	17 36	179 1
M kongai I., NS 3m., rfs., S pt.	17 28	178 58·5
(Mokungai Passage.)		
Vatu e thake, or Passage I., small, 304f.	17 22·5	178 47
OVALAU I., 8m., 2089f., LEVUKA, SITE OF SCHOOL-HOUSE, (lts. F 240 & 193f.)	17 40·7	178 51·0
Viti Levou, EW 29 l., 4000f., †, Rewa roads, Nukulau I.	18 10·2	178 31·5
— Nasalai reef, lt. Fl. 45f.	18 8	178 42
— Suva harb., ⊞″, w, h, δ, Suva pier, (lts. F 320 & 125f.)	18 8	178 26
— West extr., Navula Pt.	17 53	177 15
— Muani Vatu Pk., 4000f.	17 51	177 57·5
Mananutha grp., Hudson's Is., Mana I.	17 40·5	177 7
— Waia I., 5m., sum., 1874f.	17 17	177 9
Yasawa group, west extr. of the Is., Wiwa I., [2m.], (shl. S)	17 9	176 54
— Naviti, 740f., pk.	17 5·5	177 16
— Timboor I.	16 43	177 31·5

MARITIME POSITIONS

	(127) Places	Lat. S	Lon. E
Fiji Is.	Round I., (*Lewa Kalou*), 500f., small, (‖ W-d) ...	16°40′	177°46′
	Vatu Leile I, 110f., ✢ 8m., *l*, ✝, ⊥ N. W pt.	18 31	177 37
	Thakau Lekleka or Flying Fish shl.	18 36	177 48
	Mbenga I., [5m.], ‖₀ W, pk. 1130f.	18 23	178 8·2
	— S pt. of rf. round lagoon ...	18 31·3	177 59
	Ono I., [5m.], ‖₀, pk. 1110f. ...	18 53	178 29·7
	Kandavu, Mt. Challenger, 2180f., ✢ 9 I., ✝ ✝, (δ₀ ¼m.)	18 58·5	178 22
	N. Astrolabe reef, Solo I, lt. Fl. 96f.	18 38	178 32·2
	Great Astrolabe reef, N pt. ...	18 41·3	178 31·5
	— N'galoa harb., N'galoa ...	19 5	178 11·2
	— Denham I., W extreme ...	19 8	177 57
Islands and Reefs westward of Fiji Is.	Hammond reef	15 32	175 20
	Rotumah I., 900f., ✢ 3 I., ✝ ✝, r′, P″, Oinafa	12 29·3	177 7·5
	Eagleston reef	12 21	177 50
	Charlotte bk., 13	11 47	173 13
	Pandora rf.	12 11	172 5
	Mitre I., (*Fataka*), [1m.], vis. 4 l., ✝, P₀	11 55	170 10
	Cherry I., (*Anuda*), [3m.] ...	11 36	169 40
	Tucopia, [3m.], 3000f., T, ✝ ✝, P,	12 21	168 43
	Conway rf., [2c.], 6f., T ...	21 45	174 37·7
	Mathew rk., [⅓m.], volcanic, 465f., ⌊₀ ⌒ ...	22 20	171 20
	Hunter I., [½m.], 974f., ⌊₀ ...	22 24	172 5
	Brilliante shoal	23 14	170 5
	Walpole I., [1½m.], 229f., ⚓₀ ⌊, P₀, S pt.	22 38	168 56·7
	Durand rf, [⅔m.], ββ₀, T, δ...	22 2	168 39
	Norfolk I., 1039f., Sydney B., flag staff	29 3·7	167 58
	Loyalty Islands.		
Loyalty Isles	Maré or Britannia Is., S pt...	21 40	168 1·2
	— E pt., C. Coster	21 24	168 7·5
	— Tandine B., ⚓	21 32	167 50
	Boucher I., 90f. [4m.], ✝, mid.	21 5·5	167 49
	Chabrol I., E pt., C. Pine ...	21 1	167 24
	— Wreck Bay	20 45	167 8
	— SE pt., C. de Flotte	21 9·5	167 18·5
	Uvea or Halgan I., [6 l.] ...	20 43	166 36
	— Oidiy I., Bishop Sd.	20 28	166 30
	Beaupré Is., [2 l.], *l*, ✝, NE Id	20 22	166 14
	Astrolabe rfs., 2, ✢ 10 l., ‖₀, East reef ... O	19 50	165 56
	Petrie reef, 20f., ⚓	18 35	164 22
	I of Pines, [3 l.], lag., ⚓ W, ✝ ✝, P, Alcmene I.	22 42·5	167 28·5
	SE elbow of rf	23 1	167 2

	(128) Places	Lat. S	Lon. E
	New Caledonia.		
S. Pacific Ocean — *New Caledonia*	New Caledonia, ✢ 65 L., 5360f., E pt., Nau I.	22°15′5	167° 3′5
	C. Coronation (Unia)	22 2	166 52·5
	Balade harb., ⚓ 6, (rfs 2 l.), Id.	20 17·2	164 29·0
	NW extr., Tia I, (shl)	19 18·5	163 57
	Yandé I., peak 1000f.	20 22·5	163 49
	C. Deverd, (shl. 3 l)	20 45	164 22
	Port St. Vincent, ⊞, δ₀, ẇ, ✢ 3½m., ṙ r̄, Entr., (rfs. ✢ 4m.), Tenia I.	22 1	165 57
	Port Noumea, lt. F red	22 16·2	166 27·2
	Amédée, lt. F 164f.	22 29	166 29
	Delep Is., *l*, ✝, rfs. Tgue I. ...	19 31	163 35
	D'Entrecasteaux rfs., SW pt., Boat pass	18 40	162 46
	Huon Is., Bond reef, [⅓m.], *l*, ✝, (rfs. 3 l), N extreme, Three rocks 20f.	17 54	162 56
	Fairway rf.	21 0	161 46
	New Hebrides.		
New Hebrides	Aneityum I., EW 3 l. 2788f., ✝ ✝, w‴, b, P₀, P. Inyeu	20 15·3	169 44·7
	Erronan I., (*Futuna*), [1 l.?], 1931f., NW pt.	19 31	170 11
	Tanna I., ✢ 8 l., ✝ ✝, r, P, Port Resolution, ⊞	19 31·3	169 27·5
	— Volcano, 4m. inland, 980f.	19 32·4	169 24·5
	Immer I., small, *l*, P. 140f. ...	19 16	169 37
	Erromango, Dillon Bay, on W side, w	18 47·5	168 58
	Sandwich I (*Efate*), ✢ 10 l., ✝ ✝, Havannah harbour	17 33·3	168 16·7
	Three hill I., (*Mai*), 2171f. (rf. E pt., β) ... ⊖	17 3·1	168 24·5
	Monument rock, 397f., [11]. (Is W-d.)	17 16	168 28
	Ap I, 2800f., [6 l.], Diamond B., (*Onamavit*) ⊖	16 47·5	168 10
	Lopevi I., 4755f., pk ... ⊖	16 30·5	168 21
	Ambrym I., 4380f., EW 6 l., Dip Pt.	16 14	167 54·7
	Pentecost I., (*Arugh*), NS 11 l., 2000f., Steep Cliff B.	15 40	168 8
	Aurora I., (*Mauvo*), NS 11 l., 2000f., ✝, w, b, Laka rere	14 58	168 2
	Lepers I., (*Aoba*), 4000f., Duin Dui	15 19	167 43
	Mallicollo I., ✢ 18l., Port Sandwich, ⊞ ... ⊖	16 25·5	167 47·5
	— Espiègle B	15 58·5	167 10·7
	St Bartholomew I., (*Malo*), EW 3 l., islet SE pt.	15 43	167 15
	Espiritu Santo I., ✢ 22 l., SW pt., or C. Lisburne ...	15 38	166 46·5
	— North pt., or C. Cumberland	14 38	166 39
	Port Olry	15 1·3	167 5·5
	Pic de l'Etoile, (Star I.), (*Meralaba*), 2900f., [1 m.], pk., ✝, P₀	14 29	167 59

MARITIME POSITIONS

	(129) Places	Lat. S	Lon. E
Banks Is.	Claire I., (*Merigi*), small, 200f.	14° 17′	167° 48′
	Vanna Lava, 3120f., P. Patteson. Nusa Pt.	13 48	167 30·5
	Santa Maria, (*Gaua*), 2300f, Lakova B.	14 17	167 25
	Bligh I., (*Ureparapara*), 2440f., peak	13 32	167 20
	Torres Is, (*Ababa*). Tegua I., 600f., Hayter B.	13 15	166 33
	Santa Cruz Islands.		
Santa Cruz Is.	Vanikoro I., La Pérouse. $\frac{6I}{I6}$ 14m., sum. 3031f.	11 37	166 51·5
	— Ocili harb., on E side, ⚓	11 40·4	166 55·0
	Toupoua I, (or Edgecumbe), Basilisk hr.	11 20	166 30
	Sta. Cruz I., (*Ndeni*), 1800f, $\frac{I6}{6I}$ 8 l., E pt., C. Byron	10 41	166 8
	— S pt., C. Mendaña	10 53	165 52·5
	Volcano I., (*Tinakula*)	10 24·3	165 46 7
	Swallow group (*Matéma Panavi*), 180f.	10 17·5	166 18·5
	— Anologo, 120f.	10 6·2	165 41·7
	Goldfinch shoal	10 14·5	166 54·5
	Duff or Wilson group, NW extreme ○	9 48	166 53
	— Disappointment I., 1200f.	9 57	167 0
	— SE extr., Bass Is., 200f. ○	10 1	167 5
	Solomon Islands.		
Ids. N.E. of Solomon Is.	Stewart Is., 150f., 5 on a rf., [2 l.], *l*, ‡ †, r, P′, *Sikaiana*	8 21·5	162 42·5
	Roncador, or Candelaria rfs., rock, 10f.	6 13	159 13
	Ontong Java, or Lord Howe's Is., (*Leueneuwa*), SW ext., Toukoua I. ○	5 33	159 15
	Frindsbury rf. ○	5 0	159 9
	Tasman's Is., Nuumanno S pt	4 35	159 30
	Mortlock, or Marqueen Is., EW 7 l., centre ○	4 45	157 0
	Nine Is. of Carteret, 60f., $\frac{4}{4}$ ab. 10 l., Green I. Trading station ○	4 45	155 20
Solomon Is.	Sta. Catalina I., 320f., (*Yoriki*), pk.	10 54	162 26·5
	St. Anna I., (*U-ah*). [4m.], 520f. ‡ †, Port Mary	10 50·8	162 25·5
	St. Christoval I, (*Robatu*), $\frac{5}{6}$ 25 l., †, E pt., or C. Surville	10 49	162 21
	— Makira harbour	10 25·5	161 27
	— NE pt., C. Recherché	10 10	161 19
	Three Sisters, $\frac{2}{2}$ 3 l, 250f., N one, (*Alita*)	10 8	161 54
	Contrariété I., (*Ulana*), NS 7m., 1200f., pk.	9 46	161 57
	Ugi I., 676f., Selwyn B	10 15·2	161 42
	Maleita I., (*Mala*), $\frac{4}{4}$ 34 l., S pt., or C. Zélé	9 45	161 30
	— Mt. Kolovrat, 4275f.	9 5·5	160 57
	Alit Bay	8 59	160 45
	— NW pt., C. Astrolabe, Mallu harbour	8 22	160 30

	(130) Places	Lat. S	Lon. E
Solomon Is.	Gower I., [4 l.], *l*, ‡, S pt. ○	7° 56′	160° 28′
	Ramos Is. ○	8 19	160 9
	Guadalcanar I., $\frac{5}{6}$ 26 l., Marau sound, Ferguson I.	9 50 5	160 48·7
	— South pt., C. Henslow	9 59	160 35
	— Mt. Lammas, *h*, 8000f.	9 45	160 0
	— Wanderer B., Boyd Creek	9 41 8	159 39·5
	— South-west pt., C. Hunter	9 49	159 47
	— North extr., C. Espérance	9 14	159 41
	Florida I., 1500f., Mboli hr., Tree I	9 3·5	160 17
	Buena Vista I., 1050f., pk.	8 53 5	160 1
	Russell Is., 1600f., Pavúvu Pk.	9 5	159 3
	Murray I. (*Burakoi*) [1m.], 1000f.	9 1	158 40
	St. George I., $\frac{4}{4}$ 4 l, ‖ N, Astrolabe Creek, ⚓, w, r_o, r̄, P_o, S cove	8 30 5	159 32
	Isabel I, $\frac{4}{4}$ 40 l., S pt., 2050f., C. Prieto (Vitora I.)	8 36	159 44·5
	— Mt. Marescot, 3900f.	8 14	159 26
	— Port Praslin ○	7 25·5	158 18 5
	— C. Comfort, (rfs. 2 l)	7 19	158 6
	New Georgia I., (*Marovo*), EW 14 l., Is. (W d.), S pt., or C. Pitt, *Garukai*	8 48	158 15
	Rendova I., 2500f., C. Pleasant	8 45	157 24 5
	— Rendova harbour ⊖	8 23·5	157 19
	— Kolicara Inlet	8 10·3	157 17·5
	Eddystone rk., (*Narova*), 1100f., $P_{,,}$ (shls 5, ‡ 3m.), harb. on W coast	8 16·1	156 29·5
	Guizo I., ‡ ⊖	8 5 7	156 50
	Vella Lavella, C. Middleton, 3000f.	7 38	156 30
	Choiseul I, 1800f., $\frac{4}{4}$ 33 l., E pt., C. Labée	7 29	157 49
	— Bambatani	7 7	156 40
	— Kangopassa	6 40	156 34
	— Choiseul B., Redman I., (shl. 2 l.)	6 43·3	156 24·5
	Shortland Is., 676f., [6 l.], SE pt, C. Stephens	7 8	155 52 2
	Treasury Is., (*Mono*), [3 l.], *l*, ‡, Blanche harb., Watson I.	7 24	155 34
	Bougainville I., $\frac{4}{4}$ 44 l., C. Friendship, E end	6 42·5	155 58
	— C. Le Cras, (Id., [2 l.?])	6 0	155 20
	— Gazelle harbour	6 35	155 5
	— Mt. Balbi, 10,171f., 5 l., inland	5 56	154 54
	— C. l'Averdi	5 30	155 1
	— Buka I., ‡ †, N Cape	5 0	154 35
	— Summit of Buka I., 1306f.	5 16	154 33
	— Queen Carola harbour	5 10	154 29
	Indispensable rf., S pt.	13 2	160 31
	— NW pt.	12 15	159 59 7
	Rennell I., 400f., $\frac{4}{4}$ 12 l., SE pt.	11 52	160 40
	Bellona I., 400f., [3 l.], SE pt.	11 23	159 47

MARITIME POSITIONS

(131)	Places	Lat. S	Lon. E
	New Ireland and New Britain.		
Islands NE. of New Ireland.	Sable reef	3°33′	154°36′
	Fead Is., or Abgarris, ⁴⁄₄ 9 l., *l*, ‖₀, ‡. S. or Goodman I.	3 24	154 43
	Lyra shl., ⁴⁄₄ 4 l., 4 or 5, centre ○	1 53	153 28
	Sir Charles Hardy, or Vertes Is., 330f., [6 l.], E pt.	4 30	154 13
	St. John I., 450f., [3 l.], ‡ ‡, ‡₀, E pt. ○	4 3	153 45
	Kaan Is., [1 l.], (rky. Isl. 2 l.), centre ○	3 32	153 30
	Gerret Denys I., [5 l.], 1600f., (highest of these islands), ‡ ‡, P, mid.	3 8	152 39
	San Francisco I., 650f.	2 50	152 43
	Gardner I., and Fisher's I., (3 Is. E-d., a shl. W-d ?) NS 10 l., ab. 1600f., N pt. Fisher I.	2 36	152 1
	Squally I., [3 l.], *l*, ‡, (small Id. S-d., ‖₀) ○	1 40	150 30
	Mathias' I., [8 l.], *h*, vis. 45m., (*Tombara*), sum. ○	1 40	149 40
New Ireland	Cape Santa Maria ○	4 2	153 14
	— Holy Haven, S side	2 47·5	150 57·5
	New Ireland, W pt., C. Teschlk	2 42	150 39
	— Port Carteret, ⊞, Cocoa-nut I., 800f., NE pt., w₀, w N, ‡, ‡	4 41·4	152 42·2
	— Port Praslin, ⊞, SE corn., w	4 49·8	152 48·5
	— C. St. George	4 51	152 48·5
	Sandwich I., [4 l.], pk. 690f.	2 55	150 49
	Mausoleum I., Byron Strait, 656f.	2 42	150 33
	New Hanover, 1640f., ⁶⁄₀ 13 l., N pt., or C. Salomon Sweert	2 20	150 14
	— W pt., C. Queen Charlott	2 28	149 55
	Portland Is., EW 7m., *l*, large I.	2 37	149 39
	Duke of York I., [3 l.], w′, ŕ, Port Hunter, N side, Mitchell Pt.	4 5·5	152 28
	Father and Son reefs, Father reef	3 55	151 0
New Britain	New Britain, ⁶⁄₀ 85 l., Blanche B., Matupi I.	4 13·3	152 12·2
	— Father Pk., vol., 4000f.	5 1	151 31
	— C. Palliser	4 37	152 20·5
	— SE pt., C. Orford, ⊥, SE extr.	5 20	152 10
	— C. Quoy (pk. ⁴⁄₄ 3m.)	5 37	151 47
	— Pt. Beechey	6 9	151 2
	— Port Montague, ‡, w, r, Pt. Roebuck ○	6 15	150 36
	— South Cape, rky. islet ○	6 32	149 48
	— C. Ann	5 46	148 21
	— C. Gloucester	5 28	148 23
	Duportail Is., sum. ○	4 54	151 21
	Willaumez I., NS 5 l., S pt.	5 10	150 0
	Whirlwind reef, centre ○	4 51	148 14

(132)	Places	Lat. S	Lon. E
Bismarck Archipelago	Rooke I., ⁴⁄₄ 7 l., *h*, ‡, Dampier Strait, Luther Anchorage, C. King	5°28·3′	147°46·7
	— Tupinier I., [1 l.], *h*, ⌒	5 26	148 4
	Lottin I., [4m.], upw. of 5000f.	5 18	147 36
	Long I., NS 5 l., Réaumur Pk. at N end, 2000f.	5 16	147 6
	Mérite I., 2150f., EW 4m., mid	4 54	149 5
	North I., small, hot spring, shoal, 5m. NW	4 32	149 4
	Gipps I., hot springs	4 16	149 16
	Victoria reef	4 16	148 10
	Albert reef	3 57	147 58
	Sherburne rf., EW 4 l., rks. 20f., SE part	3 15	148 16
	Circular rf., [1 l.], T, (a lag. ‖ NW)	3 18	147 40
	Sydney shl., rks.	3 20	146 50
	Elizabeth I., [2m.], *l*, ‡, [l.] NE, P	2 55	146 49
	Purdy Is., ‡, 3 Is., P₀, (Mole, Mouse, & Bat), Bat I.	2 51	145 54
	Admiralty Islands.		
Admiralty Is.	Jesu Maria I., 700f., [& rfs. 3 l.], δ, P, SW pt., ‡	2 22	147 42
	Vandola I., 600f., [1m.], ‡, P′	2 14	148 13
	Los Reyes, 3, ⁶⁄₀ 3 l., NE one	1 59	148 5
	San Gabriel I., 12f., [2 l.], W end	2 55	147 33
	Admiralty I., 3000f., EW 16 l., NE pt., Negros Is.	1 58	147 20
	— Nares H^r, D'Entrecasteau rf., E ext. I.	1 55·2	146 41
	Western Islet, [½m.], (bk. ⁴⁄₄ 1 l.)	2 12	146 3
	Sugar loaf, 800f.	2 26	146 51
Hermit I., &c.	Anchorites Is., 3, small, [3 l.], *l*, ‖₀, ‡ ‡, P	0 54	145 30
	Commerson I.	0 45	145 17
	Hermit Is., 500f., Alacrity H^r, Pémé I. ⊖	1 28·8	145 5·7
	Boudeuse I.	1 26	144 34
	L'Echiquier Is., 30 or more, *l*, rfs., δ, NE extr.	1 6	144 30
	— SW extreme	1 40	144 3
	Durour I., small, flat	1 34	143 12
	Matty I., small, flat	1 46	142 56
	Tiger I., NS 7m., P	1 45	142 19
	Two Is. (reported 1877)	0 0	146 0

MARITIME POSITIONS

	(133) Places	Lat.	Lon. W
	NORTH PACIFIC OCEAN. Galapagos, and Islands off West Coast of North America.		
Galapagos Is.	Hood I., $\frac{6}{5}$ 9m., 640f., T, Gardner B. on NE side, ✱, b, w_o	South 1°23'4	89°40'
Galapagos Is.	Macgowen rf, [1m.], a rk. ...	1 9	89 55·5
Galapagos Is.	Chatham I., $\frac{4}{3}$ 4m, T, 2490f. E pt., Mt. Pitt, b, 800f....	0 44	89 16·5
Galapagos Is.	— Freshwater B., S side, watering place	0 56·4	89 29·2
Galapagos Is.	Charles I., $\frac{6}{6}$ 9m., 1780f., w W. Post Office B., ‡', w_o, r, Daylight Pt.	1 15·4	90 27·2
Galapagos Is.	Gardner I., [½m.], 760f., (rk. $\frac{1}{5}$ 3½m.)	1 21	90 18·5
Galapagos Is.	Albemarle I., NS 75m, 4700f., ww_o, Iguana Cove	0 59·0	91 28·5
Galapagos Is.	Narborough I., EW 17m., C. Douglas, 3720f.	0 20	91 40·5
Galapagos Is.	Indefatigable I., EW 23m., Conway B., Eden I.	0 33	90 33
Galapagos Is.	James I., $\frac{6}{5}$ 20m., James B., on W side, ‡, ẇ, E Cove	0 12·1	90 51·2
Galapagos Is.	Redondo rk., 85f., T	North 0 14	91 36·5
Galapagos Is.	Towers' I., $\frac{2}{2}$ 4m., 211f., E pt.	0 21	89 55·5
Galapagos Is.	Abingdon I., $\frac{4}{4}$ 7m., ✱, ‡' S pt., w_o, P_o, mid. 1950f.	0 34	90 44
Galapagos Is.	Wenman I., $\frac{2}{12}$ 2m., ✱$_o$, 830f., ‡ ...	1 23	91 49
Galapagos Is.	Culpepper I., [1m.], 550f., ✱, T	1 40	92 0
	Malpelo I., sum. 1200f.	4 0	81 32
	Cocos I., [4m.], r̄, Chatham B., N side, w ...	5 33	87 2
Is. off American Coast	Clipperton rk., 40f., lag. I., NS 3m., *l*, δ	10 17	109 10
Is. off American Coast	Socorro I., ab. 3707f., ✱$_o$, w_o, Braithwate B.	18 43	110 57
Is. off American Coast	Clarion, or Cloud, EW 8m., ⌊', w_o, r̄, P_o, Monument rk.	18 22	114 46
Is. off American Coast	Benedicito I., $\frac{2}{2}$ 3m., 975f., ⊥, mid.	19 18	110 50
Is. off American Coast	Roca Partida, 110f. ○	18 59	112 8
Is. off American Coast	Alijos, or Lobos, rks., 4, 112f.	24 57	115 53
Is. off American Coast	Guadalupe I., NS 4 l., 4523f., S islet	29 2	118 20
	Islands in Central Pacific.		
	Baker I. (Guano), 20f.	0 13·5	176 29·5
	Howland I. (Guano), 20f.	0 40·0	176 40
Central Pacific Is.	Christmas I., NS 6 l., lag., ✱ ‡, w_o, ‡ W, Cook Id.	1 57·3	157 28
Central Pacific Is.	Fanning I., [2m.], lag., ‡, w', r̄, P, English Hr ... ○	3 51·3	159 22
Central Pacific Is.	Washington, or New York I., [¾m.], ‡ ‡, rf. ½m., ‡$_o$, ⌊$_o$, village, W extreme	4 43	160 24·5
Central Pacific Is.	Palmyra I., EW 5 l., lag., w_o, P_o, Palm Point	5 52·3	162 5

	(134) Places	Lat. N	Lon. W
	Kingman shoal, S.E. extreme	6°23	162°18·2'
	Johnston Is., [7m.], (rf. $\frac{6}{5}$ 7m., ‖$_o$), mid.	16 45	169 28
	Sandwich (Hawaiian) Islands.		
Sandwich (Hawaiian) Is.	Owhyhee I. (*Hawaii*), NS 24 l., S pt., Ka Lae	18 54	155 42
Sandwich (Hawaiian) Is.	— Mauna Loa, mt., 13,650f.	19 29	155 38
Sandwich (Hawaiian) Is.	— Mauna Kea, 13,805f.	19 50	155 32
Sandwich (Hawaiian) Is.	— East pt., C. Kumukahi	19 30	154 51
Sandwich (Hawaiian) Is.	— Byron B, Hilo, lt. F 155f.	19 43·9	155 7
Sandwich (Hawaiian) Is.	— N pt., Upolu Pt.	20 16	155 53
Sandwich (Hawaiian) Is.	— Kawaihae B., lt. F 50f.	20 3	155 51
Sandwich (Hawaiian) Is.	— Karakakoa B. (*Kealakekua*), Cook's Monument	19 29	156 2·7
Sandwich (Hawaiian) Is.	Mowee I. (*Maui*), $\frac{6}{5}$ 14 l., E pt, Kauiki Hd, 392f...	20 46	156 0·5
Sandwich (Hawaiian) Is.	— Kolakole Pk., 10,030f.	20 42·7	156 17
Sandwich (Hawaiian) Is.	— Lahaina town, lt. F	20 52·5	156 42
Sandwich (Hawaiian) Is.	Tahourowa I. (*Kahulaui*), $\frac{6}{6}$ 5 l., ✱$_o$, W pt., (rf. 2m.) ○	20 28	156 45
Sandwich (Hawaiian) Is.	Ranai I., $\frac{4}{4}$ 7 l., ‡$_o$, Palawai Pk., 3000f.	20 49	156 54
Sandwich (Hawaiian) Is.	Morotoi I. (*Molokai*), EW 11 l., ‡$_o$, E pt., (Lanikaula)	21 9	156 43
Sandwich (Hawaiian) Is.	— West pt. (Lae-o-ka Laau), lt. F 50f.	21 6	157 19
Sandwich (Hawaiian) Is.	Woahoo I. (*Oahu*), $\frac{4}{4}$ 13 l., E pt. (Makapuu)	21 18	157 39
Sandwich (Hawaiian) Is.	— S, or Diamond Pt., 761f.	21 15	157 49
Sandwich (Hawaiian) Is.	— HONOLULU, King's cottage	21 18	157 52
Sandwich (Hawaiian) Is.	— Konahuanui Pk., (*Pali*), 3175f.	21 21	157 47
Sandwich (Hawaiian) Is.	— Pearl Locks (Honouliuli)	21 21·5	158 1
Sandwich (Hawaiian) Is.	— Laeloa Pt., lt. F 43f.	21 17	158 7
Sandwich (Hawaiian) Is.	— West pt. (Kaena)	21 34	158 17
Sandwich (Hawaiian) Is.	— North pt. (Kahuku)	21 43	157 59
Sandwich (Hawaiian) Is.	Atooi I. (*Kauai*), $\frac{6}{6}$ 11 l., Nawiliwili Hr., Sugar ho.	21 58	159 2·2
Sandwich (Hawaiian) Is.	— Hanalae B., Charlton farm	22 13	159 30
Sandwich (Hawaiian) Is.	— Waialeale Pk., 5000f.	22 3	159 31
Sandwich (Hawaiian) Is.	— Waimea	21 57	159 40
Sandwich (Hawaiian) Is.	Onechow I. (*Nihau*), $\frac{4}{4}$ 7 l., Oku Pt.	21 58	160 5·5
Sandwich (Hawaiian) Is.	— South pt., C. Kawaihoa	21 46	160 18
Sandwich (Hawaiian) Is.	— Kaeo Pk., 1500f.	21 53	160 10
Sandwich (Hawaiian) Is.	Tahoora I., (*Kaula*), [1m.] ...	21 39	160 32·5
Sandwich (Hawaiian) Is.	Bird I. (*Moku Manu*), [1m.], ✱$_o$, P_o, 880f.	23 3·2	161 55
Islands N.W. of Sandwich Is.	Necker I., [½m.], about 280f., ✱$_o$, ⌊$_o$, ~	23 35	164 39
Islands N.W. of Sandwich Is.	French Frigate shl., rf., $\frac{6}{5}$ 4 l., Id., 125f.	23 46	166 16
Islands N.W. of Sandwich Is.	Gardner I., [½m.], 170f.	25 0·7	167 59
Islands N.W. of Sandwich Is.	Maro rf., W pt., δ β, vis. 5m....	25 26	170 30
Islands N.W. of Sandwich Is.	Laysan I., δ, 25f.	25 48	171 55
Islands N.W. of Sandwich Is.	Lisiansky I., [1m.], rf. 2m., *l*, sandy, w_o, (rf. $\frac{1}{2}$ 2 l.)	26 0	174 0

MARITIME POSITIONS

(135) Group	Places	Lat. N	Lon.
			West
	Pearl & Hermes rf., SE I.	27° 47'8	175° 51'
	Midway I., SW pt. of Sand I., 57f.	28 12	177 22
	Cure I., (Ocean, Stavers), *l*, Sand Island, 20f............	28 25·7	178 29·7
	Bonin and Volcano Islands.		East
Islands South of Japan — Bonin Is.	Bonin Is., NS 14 l., N, or Parry's grp., $\frac{4}{7}$ 3 l., N rk.	27 45	142 7
	Kater I., [& rks. 1½m], N rk.	27 31	142 12
	Peel I., NS 5m., SW islet......	27 2	142 10
	— Port Lloyd, ⊞. w, b, r, ř, Kyosé	27 5·6	142 11·5
	Bailey Is., Aoe Tima	28 33	142 9
	Rock, ł ....○	29 37	141 58
	Rosario (or Disappointment) I., 148f., [1m.], rky, ⊥, ✶₀, β	27 16	140 51
	Volcano Is., 3, Sulphur I., $\frac{4}{7}$ 5m., 644f.	24 48	141 20
	— N Id., San Alessandro. 2534f.	25 24	141 18
	— S Id., San. Augustino. 3039f.	24 18	141 28
	Forfana (late Arzobispo) I. .	25 43	140 43·5
	Rock, 7f........................○	24 2	137 59
	Rica de Oro rk., or Lot's Wife, 466f.	29 45	140 22
	Rasa I, $\frac{4}{7}$ 5m., ✶, 220f. ...○	24 30	131 22
	Borodino Is., 2, NS 4 l., *l*, Sandy, P., N one, 40f. ...	26 2	131 20
	Parece Vela (Bishop. Douglas, Nautilos), a rk 12f., in a lag., [1 l.], β	20 28	136 13
	Ladrones.		
Mariana Is., or Ladrones	Santa Rosa shoal ....○	12 30	144 15
	Guam, or Guahan I., $\frac{4}{7}$ 9 l., Cocoa I.	13 13	144 38
	— San Luis de Apra, ⊞, w. r, fort	13 25·8	144 39·5
	— North pt., Pt. Ritidian......	13 39	144 51
	Rota I., $\frac{4}{7}$ 4 l., about 800f. ...	14 7·5	145 13
	Aguijan I., [1 l.], centre	14 51	145 31
	Tinian I., NS 4 l., ‖₀ N, Anson's B. at SW part, ‡₀, w, r, Anson Bay............	14 59·4	145 36·2
	Saypan I., $\frac{4}{7}$ 4 l., ab. 1200f., ł, w, r, (rf. W-d.), N pt.	15 17·5	145 46·5
	Bird I., or Farallon de Medinilla, $\frac{4}{7}$ 2m., ab. 50f. rks.	16 0	146 0
	Anataxan I., *h*, ‡₀, ł, E pt.	16 20	145 41
	Sariguan I.	16 40·5	145 46
	Zealancia bank (Piedras de Torres) δ ....○	16 52	145 49
	Guguan I., NS 2m., E pt.......	17 18·5	145 51·5
	Alamagan I., 2316f., E part...	17 35	145 52
	Pagan I., W end. 1000f.	18 3·5	145 53
	Agrigan I., P., W end	18 50	145 37
	Assumption I., [3m.], 2848f. ł W, w, l,...................	19 45	145 29·0
	Urracas, 3 rks.	20 0	145 21
	Farallon de Pajaros, 1089f. ...	20 32	144 54

(136) Group	Places	Lat. N	Lon. E
Detached Is. and Reefs	Grampus Is. (Sebastian Lobos?). E.D..................	25° 10'	146° 40'
	Marcus I., 60f.	24 14	154 0
	Wake, or Halcyon I., [3m.], *l*, lag., ✶, ł₀, w₀, ř, 8f...	19 11	166 31
	Gaspar Rico, or Cornwallis, (*Toangi*), vis. 5m., Scylla rks., NS 2 l..............	14 50	169 5
	Marshall Islands.		
East chain, Ratack Is.	Bikar, or Dawson Is., [4 l.], 9f. S I.	12 14	170 15
	Button, or Kutusov Is. (*Utirik*), N I. ....○	11 18	169 54
	— S grp., Taka Is., S pt.......	11 3	169 46
	Krusenstern, Tindle & Watts (*Ailuk*). Is., $\frac{4}{12}$ 5 l., Kapenir I.	10 27	170 0
	Count Heiden, or Lekieb Is., $\frac{4}{4}$ 8 l., S pass. 14f.........	9 49	169 22
	Jemo I., or Steep to ....○	10 6	169 42
	New Year I., (*Miadi*), NS 3m., *l*, ł	10 18	170 55
	Chatham Is., N grp., Romanzoff, (*Otdia*), Port Noel, E islet	9 28	170 17
	— S grp., Erikub, $\frac{4}{4}$ 8 l., S extr., (*Airik*)	8 55	170 8
	Calvert Is., $\frac{4}{4}$ 10 l., NW one, (*Kaven*)	8 51	170 49
	· South extreme	8 30	171 10
	Ibbetson Is., (*Aurh*), $\frac{4}{4}$ 4 l., NE pt.	8 21	171 2
	Arrowsmith Is., (*Majuro*), $\frac{4}{5}$ 6 l., Caroline I., W. pt.	7 10	171 13
	Arhno Atoll, Ine I.	6 53	171 43
	Mulgrave Is., [6 l. ?], small, rts., ‖₀, Port Rhin	6 14	171 46
	Keats shoal. δ.	5 55	173 38
West chain, Ralick Is.	Boston, or Ebon Is., Jurij I.	4 36·5	168 41·5
	Bonham Is., (*Jalut*), $\frac{4}{4}$ 8 l., SE pass	5 55·5	169 43
	Hunter I., [2m.], (*Kili*).........	5 42	169 9
	Baring Is., Namorik ....○	5 35	168 5
	Elmore, or Odia Is., $\frac{4}{7}$ 7 l., South Pass	7 15	168 48
	Musquillo Is., $\frac{4}{4}$ 12 l., rts., ‖₀, W pt. Nama I.	8 14	168 3
	Lib I., 14f.	8 19	167 28
	Mentschikoff Is., $\frac{4}{6}$ 20 l., Ebadon I.	9 22	166 53
	Lae I., W pass	8 58	166 27
	Uja, or Catharina Is., NW I.	9 21	165 36
	Schanz Is., $\frac{4}{4}$ 5 l., Wottho I., 14f..........................	10 10	166 6
	Rongelab, or Pescadores Is., 14f., P₀, South I.	11 15	167 0
	Rongerik Is., $\frac{4}{6}$ 18 l., Rock I.	11 24	167 35
	Ailinginæ Is., Knox I.	11 4	166 30
	Bikini or Eschholtz Is., $\frac{4}{12}$ 7 l., NW extr.	11 42	165 25

MARITIME POSITIONS

(137) Places	Lat. N	Lon. E
Eniwetok, or Brown's group, [8 I.], ✝ ✝₀, lag., P₀, West Point	11°31′	162° 5′
— SE islet, or Parry	11 21	162 25
Arecifos, or Providence Is., rfs, ‖₀ ?, Uyelang I., 14f.	9 42	161 1
Greenwich Is., (*Kapinga-marangi*)	1 4	154 45
Indiana reef	3 20	160 18
Two Is. (reported 1877)	0 0	146 0
Caroline Islands.		
Caroline Is.		
Ualan I., (Strong I.), ⁴⁄₄ 8m., Coquille Harb. on NW side, ⊞, w. r. NE islet	5 21·3	163 0·7
— Mt Crozer, ab. 2155f.	5 19	163 2·5
Pingelap, or MacAskill Is., 3, [2m.], Tugulu I.	6 14·5	160 52
Duperrey Is. & rf., ²⁄₂ 3m., or Mokil I., S pt.	6 39	159 53
Seniavina Is., 3 grps., ⁶⁄₆ 13 l., Ponapi I., EW 5 l., ✝ ✝, P, Tolocolme Pk., 2861f.	6 53	158 12
Andema Is., ⁶⁄₆ 3 l., rfs., S pt.	6 44	157 54
Pakin, or Paguenema Is., Kapenuar I.	7 6	157 43
Ngatik Is., EW 3 l., *l*, ✝ ✝, ‖₀ P, E pt	5 48	157 31·5
Bordelaise I., S. Augustin I., 107f., [½m.], ✝ (δ NW. rf. SE 3 l.)	7 37	155 9
Monteverde Is., Nukuor, E pt., ⁴⁄₄ 2 l., lag.	3 52	155 0
Mortlock Is., ⁴⁄₄ 6 l., ✝, Lukunor I., EW 7m., lag. Port Chamisso, ⊞, ✝ ✝, ww₀, Entr.	5 20	153 58
— Etal Is., NS 4m., N pt.	5 37	153 42
— Ta, or Sotoang grp., S pt.	5 17	153 48
Namoluk Is., 100f., (*Tainome*), 3, ⁴⁄₄ 3m., *l*	5 55	153 16
Losap I.	6 53	152 43
D'Urville I., 3 islets on a rf., *l*, ✝, β	6 59	152 34
Truk Is. (*Hogolu*), ²⁄₂ 15 l., P, S islet ⊖	6 57	151 58
— Tsis I., [¾m.], rfs., ✝ ✝, ✝ N, ⚓ NW, N pt. ⊖	7 18·5	151 48·5
Mourileu grp., ⁶⁄₆ 7 l., E isle	8 42	152 26
Namolipifan grp., ⁴⁄₄ 5 l., lag. ‖ S, Namune islet	8 25	151 49
Lutke I., or East Faiu, [¾m.], rfs., ✝ ✝, ww₀	8 33	151 26
Namonuito grp., EW 15 l., E islet, Pisaras	8 34	150 32
— N extr., or Magur islet	8 59·7	150 14·5
— W extr., or Ulul islet	8 36	149 47
Martyrs' Is., NS 7m., ✝, P, N isld., Ollap ○	7 37	149 31
— S Id. Tamatam, (W Id. Fanadik) ○	7 32	149 30
Enderby Is. 2, ✝, ✝, (a bk. 7, ⁴⁄₄ 2 l.), (NW one, Alet; SE one, Pozoat)	7 20	149 17

(138) Places	Lat. N	Lon. E
Caroline Islands		
Suk I., or Pulusuk I., NS. 2m., *l*, ✝ ○	6° 40′	149°21′
Ianthe and Nile Shoals, [½m.], sf., P.D. ○	5 53 / 5 32	145 39 / 145 42
Pikelot Coquille, [⅓m.], on a rf, ✝ ✝. P₀	8 9	147 42
Faiu I., West. rf. ⁶⁄₆ 5m., islet in middle, ✝	8 3	146 50
Satawal (Tucker) I., [1m.], P	7 22	147 6
Swede Is., (Lamotrek), 6, ⁶⁄₆ 2 l., S & E islet	7 27	146 31
— Elato Is., NS 2 l., N pt.	7 30	146 19
Olimarao Is., ⁴⁄₄ 2m., N islet	7 43	145 56
Faraulep Is., 3, [2m.], lag., S pt. ⊖	8 35	144 36
Ifalik Is. (Wilson), [2m.], lag., SW extr.	7 14	144 30
Ulie Is. (Thirteen Is.), EW 6m., E, or Raur I. (⊞ 16 E, ‖ SE), N pt	7 21·5	143 57·5
Iuripik (Kama), 2 Is., ⁶⁄₆ 2½m., E pt.	6 40	143 11
Sorol, Philip Is., S.E I.	8 6	140 24
Feys, or Tromelin I., [1m.], *l*, ✝, no lag., ⚓₀, L, 30f.	9 46	140 35
Uluthi Is. (Mackenzie), ⁴⁄₄ 7 l., lag. *l*, ✝, N extr., Mogmog I.	10 6	139 46
— S extr, Pugelug I.	9 46	139 41
Yap I., 1150f., NS 3 l., ✝, (rf. S-d.), Tomil B., lt. F, 25f.	9 25	138 6
Hunter's reef	9 58	138 23
Matelotas Is. (Ngoli), ²⁄₂ 9 l., *l*, ✝ ✝, ‖₀, S l.	8 15	137 35
— North I., 150f.	8 35	137 40
Pelew Islands, &c.		
Pelew Is.		
Palao or Pelew Is., ²⁄₂ 29 l., ✝, P, (rfs. NW-d), Korror Hr ⊖	7 19	134 32
— Kajangle I., [2m.], (rf. ⁴⁄₄ 4 l.)	8 3	134 38
— Baobeltaob, N extr., reef	7 47	134 33
— Angaur I., 4m, w, L₀, S pt.	6 50	134 10
Islands N.E. of Gillolo ⊖		
Pulo Marière, Warren Hastings I., NS 2m., vis. 4 l., ✝ ○	4 19	132 28
Pulo Anna, or Current I., [½m.], *l*, ✝ (rf. W. 1m.), vis. 10m	4 38	132 2
Sonserol Is., or St. Andrew, 2, small, *l*, ✝, ‖₀, vis. 12m.	5 20	132 16
Nevil I., or Lord North, ⁶⁄₆ 1½m., *l*, ✝, (rf. E)	3 2	131 5
Helen, or Carteret shl., δ ⁴⁄₄ 5 l., rks. 4f., N pt. islet, 2 ✝	3 0	131 52
St. David's, or Freewill Is., 4, ²⁄₂ 5 l., *l*, ✝ ✝, P mid., vis. 18m.	0 57	134 21

MARITIME POSITIONS

Region	(139) Places	Lat. N	Lon.
	ARCTIC ARCHIPELAGO.		
			East
Franz Joseph Land	FRANZ JOSEPH LAND, Wilczek I., C. Hansa	80° 23′	59° 32′
	C. Flora. Jackson wintered (1895–6)	79 55	49 40
	C. Mary Harmsworth	80 28	42 0
	Frederick Jackson I. Nansen wintered (1895–6)	81 13	55 45
	C. Germania, 1200f	81 58	57 45
	Hvidtland	81 38	63 0
	Nansen's farthest (1895)	86 5	96 30
	Fram's farthest (1895)	85 57	66 0
	Capt. Cagni's farthest (1900)	86 34	64 30
	C. Grant	80 0	47 40
	Gillis Land (1707) ....○	81 30	36 0
	King Charles Is., East extr ○	79 0	32 40
	— Swedish Forelaad, N extr.	78 50	26 40
	Spitzbergen.		
	Smeerenberg, ⚓′, m sd..........	79 43	11 15
	Hackluyt's Headland...........	79 47	11 5
	Cloven Cliff ....⊕	79 45	11 45
	Moffen I., [2m], *l*, N pt.	80 1	14 42
	Vertegen Hook, *T* ....⊕	80 4	16 25
	Treurenberg B , Hecla Cove, ⚓′	79 55 3	16 57
	Hinlopen St. Hyperite I. ...⊕	79 42	19 0
	North Cape......................	80 32	20 14
	Walden I., $\frac{4}{4}$ 1½m., b., NW pt.	80 36	20 0
	Little Table I., [⅓m.], 750f....	80 48	20 22
	Charles XII. I.	80 43	25 12
	Parry's farthest (July 1827)...	82 40	19 0
Spitzbergen	C. Leigh Smith	80 11	28 7
	C. Molen..........................	79 15	25 0
	Ryk Yse Is., E. pt...........○	77 50	26 0
	Thousand Is., High rk.	77 2	21 20
	Stor Fiord, Fox Ness.........⊕	78 3	19 2
	Hope I., $\frac{6}{6}$ 9m., W pt..........	76 37	25 30
	S. Cape, or Look-out...........	76 27	16 50
	Hornsunds Pk., 4560f	76 54	16 18
	Bel Sd , Separation Pt. ......⊕	77 38	14 50
	Ice Sound, pt. S side, entr...○	78 7	14 7
	Charles I., S., or Saddle Pt. ○	78 13	12 30
	Fair Foreland..................○	78 58	10 35
	Cape Mitra........................	79 5	11 29
	Bear, or Chérie I., 1200f., South Hr.......... ...... ○	74 22	29 18
			West
	JAN MAYEN I., C. Northeast, or Young's Foreland......	71 8	7 50
	— Mt. Beerenberg, 5836f. ...	71 4	8 10
	— C. South	70 49	9 8
	Iceland.		
Iceland	Portland I.........................	63 23	19 6
	Hvalshak rk.	64 40	13 12
	E. extreme, or Pt. Gepirhuk...	65 5	13 26
	C. Langanaes	66 23	14 30
	C. Revsnig	66 33	16 9
	Grimsey I., $\frac{2}{7}$ 1m., N pt.......	66 34	18 1
	Mevenklint........................	67 9	18 31
	North C............................	66 28	22 26

Region	(140) Places	Lat. N	Lon. W
	W pt., or Staalburghuk	65 30′	24° 30′
	Sneefeldsyökel, 4696f.	64 48	23 43
	Reikiavig, Holmenshaven......	64 8·6	21 53
	C. Reikianes, lt. F 180f.........	63 49	22 40
	Mt. Heckla, 5364f.	63 58	19 38
	Oster Yökel, 5964f..............	63 36	19 33
	Westmanoerne Is., S pt.........	63 24	20 15
	Greenland.		
Greenland, East Coast	C. Bismarck	76 47	18 30
	Shannon I., $\frac{6}{6}$ 8 l., S pt., or C. Philip Broke.........	74 55	17 33
	Pendulum Is., 2, $\frac{4}{4}$ 5 l., 3000f	74 38	18 30
	C. Borlase Warren..............	74 14	19 23
	C. Hold with Hope of Hudson, 3000f.	73 26	20 29
	Boutekoe, EW 3 l., SE pt. ...	73 29	20 40
	C. Parry ....○	72 22	22 2
	Traill I., C. Young ....○	72 16	21 52
	Canning I., C. Wardlaw ...○	71 47	22 0
	Liverpool I., NS 23 l, S pt. ...	70 26	21 55
	— Church Mt., 2967f.	71 4	21 37
	Rathbone I., E pt.	70 40	21 15
	C. Brewster, ⊥	70 11	22 0
	C. Tupinier.....................○	68 42	25 5
	King Christian IX. Land, Leifs I., 2300f.	65 55	35 30
	Hoidsadlen I......................	65 3	39 5
	C. Moltke	63 36	40 22
	C. Adelaer	61 49	42 0
	C. Farewell, vis. 30 l.	59 49	43 54
Davis' Strait	C. Desolation	60 44	48 6
	Frederickshaab Church.........	61 59	49 44
	Lichtenfels	63 3	50 47
	Godthaab	64 10	51 46
	Holsteinburg	66 56	53 42
	Whalefish Is., Kronprindsens I., ⚓, fl. st............	68 58·9	53 14·0
	Disco I., $\frac{4}{4}$ Issungoak Pt.......	69 39	51 55
	— North pt., Iglorpait	70 19	54 36
	— Godhavn	69 13 9	53 42
	Waygat, or Hare I., [5m.] ...	70 27	54 45
	Black Head........................	71 38	55 50
	Sanderson's Hope	72 42	56 15
	Upernivik	72 46·9	56 2·7
	C. Shackleton, 1400f............	73 44	56 40
	Devil's Thumb, 1300f.	74 20	56 47
	Red Head	74 58	57 15
Baffin's Bay	Sabine's Is., SW one ....○	75 25	58 50
	C. York, Immagen...............	75 55	66 33
	C. Dudley Digges, ⊥, 800f. ...	76 8	68 43
	North Star B., (Saunders wintered 1849)	76 32	68 45
	Cary's Is , Southern	76 40	72 41
	C. Parry	77 26	71 8
	Hackluyt I. (*Agpaysuak*), W pt.	77 19	72 30
Smith's Sound	C. Alexander	78 11	73 21
	Port Foulke	78 18	73 0
	Rensselaer B. (Kane wintered 1853–4–5)	78 37	70 53
	M'Gary I.	79 16	65 0
	C. Calhoun	80 6	67 23
	C. Constitution	80 33	66 30
	Joe Island	81 22	63 31

MARITIME POSITIONS

Region	(141) Places	Lat. N	Lon. W
Arctic Sea	Thank-God Hr., Hall's Rest.	81° 37′	61° 37′
	C. Bryant	82 23	54 46
	Mt. Hooker	82 30	50 41
	C. Britannia, 2050f.	82 44	49 00
	C. Beaumont	82 48	50 30
	Markham I., C. Neumayer	83 1	48 0
	Lockwood I., Lockwood's farthest (1882)	83 25	40 45
	C. Robert Lincoln ○	83 32	39 35
	Grant and Grinnell Land.		
	C. Alfred Ernest	82 14	85 55
	C. Columbia	83 7	70 23
	C. Joseph Henry	82 49	63 36
	Markham's farthest (1876)	83 20·5	63 7
	C. Sheridan (Sir G. Nares wintered 1875–6)	82 26	61 21
	C. Union	82 15	61 8
Smith's Sound	Discovery Harbour	81 43	64 46
	C. Baird	81 32	64 32
	C. M'Clintock	79 58	70 50
	C. Louis Napoleon	79 38	72 19
	C. Sabine	78 43	74 15
	C. Isabella	78 16	75 33
	Clarence Head	76 41	77 48
	Cobourg Is., East I., Princess Charlotte Monument	75 39	77 45
Lancaster Sound	**North Devon.**		
	C. Horsburgh	74 55	79 3
	C. Osborn	74 24	81 42
	C. Warrender	74 28	81 51
	C. Bullen	74 22	85 0
	C. Hurd, ⊥	74 32	90 3
	C. Riley	74 40	91 48
	Beechey I. (Franklin wintered 1845–6)	74 43	91 45
	Baring B. (Belcher wintered 1853–4)	75 40	91 52
	N. Cornwall, Mt. Greenwich	77 36	94 41
Barrow Strait	**Parry Islands.**		
	Cornwallis I., C. Hotham	74 38	93 34
	— Assistance B.	74 37	94 16
	Griffith I., $\frac{4}{14}$ 8 l., S pt.	74 28	95 20
	Lowther I., $\frac{12}{7}$ 9 l., S pt.	74 26	97 40
	Bathurst I., C. Cockburn, *h*	75 3	100 23
	— Lyall Pt.	76 39	104 58
	— Sherard Osborn I., N pt.	76 47	100 0
	Byam Martin I., C. Gillman	75 0	104 8
	Melville I., $\frac{16}{61}$ 44 l., Winter Harb. (Sir E. Parry wintered 1819–20) ⊕	74 47·2	110 48 ?
	— W extreme, C. Russell	75 14	117 40
	— N extreme, Markham I.	77 00	109 43
	Eglington I., C. Nares	75 34	119 30
	Prince Patrick I., Land's End	76 16	124 6
	Polynia Is., Ireland's Eye	77 49	115 30

Region	(142) Places	Lat. N	Lon. W
Prince of Wales Strait	**Banks Land.**		
	C. M'Clure	74° 33′	120° 50′
	— Bay of Mercy (Investigator abandoned 1853)	74 14	118 15
	Prince Alfred, C.	74 7	124 0
	— C. Kellett	71 55	125 28
	— Nelson Head	71 2	122 24
	— Princess Royal Is. (M'Clure wintered 1850–1)	72 45	117 44
	Prince Albert Land.		
	Prince of Wales Str., Peel Pt.	73 20	113 54
	Ramsay I. (Collinson wintered 1851–2)	71 36	119 5
	C. Wollaston	71 3	118 9
	C. Baring	70 0	117 0
	C. Back (Rae's farthest 1851)	70 9	116 0
Dease Strait	**Wollaston and Victoria Land.**		
	C. Lady Franklin	68 33	113 10
	Cambridge B. (Collinson wintered 1852–3)	69 5	105 10
	Point Back	68 55	103 16
	Lind I., South pt.	68 37	102 5
	Gateshead I.	70 25	100 38
Victoria Strait	**King William Land.**		
	Victoria Strait (Erebus and Terror abandoned 1848)	69 49	98 49
	C. Felix	69 55	97 55
	Pt. Franklin	69 28	99 10
	C. Crozier	69 4	100 4
	C. Herschel	68 42	98 2
	Mount Matheson	68 45	95 7
McClintock Channel	**Prince of Wales Land.**		
	Cape Swinburne	71 12	99 00
	Pt. Allen Young	72 10	101 55
	Minto Head	73 4	102 40
	Parker I.	74 14	100 35
	Palmerston Pt., 600f.	74 7	97 44
	Cape McClure	72 50	96 36
Prince Regent Inlet	**North Somerset.**		
	C. Rennel	74 7	93 14
	Leopold Is., N one, ⊥, E pt.	74 3	89 53
	Port Leopold (James Ross wintered 1848–9)	73 50	90 12
	Batty Bay	73 13	91 8
	Fury Pt. (H.M.S. Fury abandoned Aug. 1825; Sir J. Ross wintered 1832–3)	72 40·5	91 53
	C. Garry	72 23	93 17
	Bellot Strait, Pt. Kennedy (M'Clintock wintd. 1858–9)	72 2	94 14
	Cockburn Island.		
	C. Kater	71 54	89 59
	Sherer's Mt.	73 2	89 20

MARITIME POSITIONS

Region	(143) Places		Lat. N	Lon. W
Lancaster Sound	Port Bowen (Parry wintered 1824–5), Stony I.	⊕	73° 13'6	88° 54'7
	C. York	⊖	73 50	86 40
	C. Crawford	⊖	73 53	83 50
	C. Charles York		73 50	82 0
	C. Hay		73 52	79 50
	Possession Mt, 2200f.		73 22	77 35
	C. Walter Bathurst		73 28	76 36
	C. Graham Moore	○	72 56	76 10
	C. Bowen	○	72 21	74 45
	C. Adair	○	71 32	71 29
	Agnes' Monument, ⊥, 40f.	○	70 33	68 15
	Cape Raper		69 44	67 30
	C. Kater	○	69 12	66 53
	Cumberland Island.			
Davis' Strait	C. Searle	○	67 13	62 22
	Cape Dier of Davis	○	66 48	61 15
	Mt. Raleigh, *h*	○	66 34	62 18
	C. Walsingham	○	66 4	61 15
	C. Mercy of Davis		64 51	63 43
	Cumberland Sd., Nijadluk Harbour		65 7	64 25
	— Kingaite Fiord, Union Hr.		66 23	66 25
	Kingawa Fiord	○	67 16	68 0
	— Harrison Pt.		64 57	66 5
Hudson Strait	Hall I., Mt. Warwick	○	62 33	64 0
	Frobisher B., Jordan R.		63 45	68 55
	Resolution I, ⅘ 13 l., E pt., or C. Warwick	○	61 40	64 30
	— S pt., or Hatton's Headland, or C. Best		61 21	65 0
	Lower Savage I.		61 35	66 7
	Saddleback I.	○	62 11	67 43
	Upper Savage I., ⅘ 3 l., E pt.	○	62 33	70 0
	North Bluff		62 32	70 25
	Fox Land.			
Fox Channel	King Charles Cape	○	64 22	77 50
	Queen's C.	○	64 45	78 12
	C. Weston	○	65 35	78 12
	C. Dorchester	○	66 21	78 0
	Pt. Peregrine (Fox's farthest, 1631)		66 40	76 50
	Southampton Island.			
Southampton I.	Southampton Is., ⅘ 83 l., N pt., or C Frigid	○	65 59	85 30
	— E extr., or Seahorse Pt.	○	63 35	80 7
	— C. Kendall		63 42	87 15
	Tom I, [4 l.], S pt.	○	63 10	87 0
	Coats I., C. Pembroke	○	63 0	81 20
	— S extr., or C. Southampton	○	62 10	83 45
	NORTH AMERICA.			
	Pt. Barrow, (Noowook)		71 23	156 22
	Port Moore (Maguire wintered 1852–4), MAGNETIC OBSERVATORY	⊕	71 21·4	156 16
	Tangent Point		71 10	154 46
	C. Halket		70 49	152 15
	Pt. Beechey		70 24	149 37

Region	(144) Places		Lat. N	Lon. W
Arctic Sea	Return reef	C	70° 25'	148° 30'
	Flaxman I., 50f., N side		70 11	145 50
	Camden B. (Collinsoo wintered 1853–4)		70 8	145 29
	Pt. Manning		70 7	143 40
	Herschel I., S pt.		69 34	138 54
	Mt. Cupola		68 45	137 53
	Mackenzie R., Shoalwater B.		68 49	136 27
	Pelly Is., [1 l.]		69 32	135 33
	Pullen I.		69 45	134 20
	Warren Pt.		69 47	131 35
	C. Dalhousie		70 16	129 10
	C. Bathurst		70 36	127 30
	C. Parry, NE pt.		70 6	123 35
	Keats Pt.		60 49	122 0
	Sir S. Clerk's I., SE pt.		69 33	118 0
	C. Bexley		69 0	115 52
Coronation Gulf	C. Krusenstern		68 28	113 54
	Coppermine R., mouth, E side		67 48·5	115 31
	C. Flinders		68 14	109 14
	Back's Western River		66 28	107 49
	Turnagain Pt.		68 39	108 35
	C. Alexander		68 55	106 19
	Melbourne I, EW 6 l., E pt.		68 29	104 30
	White Bear Pt.		68 9	103 30
	O'Reilly I., [4 l.], NW pt.		68 12	99 24
	Cape Gedde		68 31	98 5
	Pt. Ogle		68 17	96 15
	Cockburn B., mouth of Great Fish or Back River		67 13	95 24
	Castor and Pollux R (Dease and Simpson 1839, Rae 1854)		68 32	94 0
James Ross Strait	Stanley Island		68 44	94 50
	Hull Bay		69 20	93 42
	Boothia Isthmus, Josephine B.		69 39	94 40
	MAGNETIC POLE (1831)		70 5	96 47
	C. Nikolas		70 25	97 0
	C. Hobson		71 26	95 55
	Murchison Promontory, Northern pt. of America.		72 0	94 37
Boothia Gulf	Elizabeth Harbour		70 38	91 46
	Victoria Harb. (Ross abandoned the Victoria 1831–2)		70 9 3	91 25
	Felix Harb., M'Diarmid I. (Ross wintered 1829–30)		69 59·7	91 50
	Pelly Bay, Parker Peak		68 25	89 36
	C. Chapman		69 15	89 0
	Rae Isthmus, C. Simpson		67 20	87 2
	Cape Richardson		68 50	85 15
Melville Peninsula	C. Englefield, Fury and Hecla Strait		69 51	85 30
	C. Hallowell, (N head of do.)		69 57·5	85 26
	Igloolik I., EW 9m., (Parry wintered 1822–3), E pt.	⊕	69 21	81 31
	Arlagnuk		69 12	81 30
	Ooglit Is.		68 58	81 4
	Ooglit I., [2m.], *l.*		68 24	81 38
	C. Jermain		67 47	82 0
	C. Penrhyn		67 25	81 25
	Winter I., ⅘ 10m., *l*, S pt., or C. Fisher (Parry wintered 1821–2)	⊕	66 11·4	83 10·0

MARITIME POSITIONS

Region	(145) Places	Lat. N	Lon. W
Rowe's Welcome	Baffin I., 4/4 7m., SE pt.	65°40′	83°29′
	Repulse B., head Fort Hope...	66 33	86 56
	Wager R., S cape of entr. ...	65 13	87 28
	HUDSON'S BAY.		
	Chesterfield Inlet, Wagg I... ○	63 21	91 14
	— Head of inlet	64 0	95 50
	Marble I., E part .... ○	62 41	90 30
	Whale Cove .... ○	62 10	92 50
	C. Esquimaux................ ○	61 8	94 0
	Churchill Battery Beacon... ○	58 46	94 10
	C. Churchill .... ○	58 52	93 14
	York, factory, r_o, $\bar{r}$	57 2	92 26
	C. Tatnam .... ○	57 22	91 10
	Severn Fort.................... ○	55 58	89 12
	C. Lookout .... ○	55 23	85 13
James' Bay	C. Henrietta Maria...............	55 9	82 45
	Albany Fort .... ○	52 12	81 50
	Moose Fort........................	51 13	80 40
	Rupert's House .... ○	51 23	78 29
	East Main Fort .... ○	52 10	78 32
	North Bear I .... ○	54 27	81 6
	Agoomska I., 2/2 17 l., S pt. ○	52 49	81 0
	South Cub .... ○	53 57	79 42
	Long I., 2/2 6 l., S pt......... ○	55 0	78 48
	Richmond B., entr............ ○	56 14	77 15
	South Belchers, centre ...... ○	55 55	89 48
	King George's Is., centre ... ○	57 30	80 10
	Sleepers, N part.............. ○	58 18	80 40
	Brothers, East Bro. .... ○	58 37	80 0
	Ottawa Is., NE I. .... ○	59 55	79 38
	C. Dufferin .... ○	58 46	79 11
	Smith I. .... ○	60 50	79 7
Hudson's Strait	Mansfield I., 2/2 19 l., South pt.................. ○	61 33	80 20
	— North pt..................... ○	62 37	79 52
	C. Wostenholme.............. ○	62 37	77 26
	Digges Is., W extreme ...... ○	62 34	78 5
	Nottingham I., 4/4 14 l., S pt., (δ shl. 7m.) ...... ○	63 6	77 50
	Salisbury I., 6/6 9 l., SE pt.......	63 22	76 30
	Mills I., N pt.................. ○	64 4	77 50
	Charles I.. C. Moses Oates ○	62 47	74 0
	C. Weggs, Island .... ○	62 31	74 0
	Stepart Bay	61 33	71 33
	C. Hope's Advance...............	61 17	70 2
	Green I. .... ○	60 8	67 52
	Akpatok I., E end	60 10	66 36
	Koksoak R., The Wort, 165f...	58 29	68 7
	Fort Chimo.......................	58 8	68 18
	LABRADOR.		
Labrador	C. Chidleigh, 1500f.	60 33	64 15
	Button Is., NS 3 l., vis. 7 l., NE pt.........................	60 51	64 39
	Eclipse Harb., Mt Bache, 2150f.	59 50	64 2
	Nachvak B., H. B. Co. Post ...	59 3	63 52
	Hebron Mission Station.........	58 10	62 40
	Mt. Thoresby, 2773f., Port Manvers, w, h............ ○	56 53	61 19
	Nain	56 32·9	61 40·7
	Hopedale Harb. Obs......... ⊕	55 27·1	60 12·5

Region	(146) Places	Lat. N	Lon. W
Labrador	Aillik Harb., C. Mokkovik ...	55°13′·5	59°18′·2
	Webeck Harb., Harbour rocks	54 54·5	58 2·7
	White Bear Is., Middle I., 190f.	54 28	56 55
	Hamilton Inlet, Rigoulette ...	54 10·8	58 25·2
	— Goose B., Rabbit I.	53 23	60 9
	Cape Porcupine, 343f.	53 56	57 8
	Outer Gannet I., 104f.	54 0·3	56 31·5
	Cartwright Hb., Caribou Castle	53 42·6	56 59·7
	Gready Harb	53 48	56 25·7
	Indian Tickle, Indian Id., 360f.	53 34·2	55 59·5
	Roundhill I., 174f...............	53 26	55 36
	Occasional Harb. Obs.	52 40	55 44·2
	C. St. Francis. 115f.	52 33·5	55 41·5
	C. St. Lewis, St. Lewis rk. ...	52 21·7	55 37·2
	Battle Is., Double I., 130f......	52 15	55 33
	Table Head.........................	52 6	55 41
	Belle Isle, 2/2 9m., lt. F 470f.	51 53	55 22·2
Strait of Belle Isle	Chateau B., Castle I., S pt. ...	51 58	55 50
	Amour Pt., lt. F 155f.	51 27·5	56 51
	Greenly I., lt. Rev. 100f.	51 22·7	57 10·5
	Bradore hills, sum. 1264f.......	51 34	57 12
	Old Fort I., [1½m.]	51 22	57 47
	Shag rks.	51 10	58 18
	Eagle Harb., E side, entr.......	51 0	58 41
	Grt. Mecatina I., 2/2 3½m., SE pt.	50 44	58 53
	Murr Is. and rks., [1 l.], E extr.	50 42	58 50
	Little Mecatina I., 2/2 6m., S pt	50 31	59 21
	St Mary rks., [2m.], S pt. ...	50 13	59 45
	South Maker's ledge	50 9	59 57
	C. Whittle, (rks. 4/4 3m.)	50 11	60 8
	NEWFOUNDLAND.		
Newfoundland, E. Coast	Quirpon I., N pt., or C. Bauld, T, lt. Alt. 141f. ...	51 38·8	55 25
	Bell I., (S end)	50 42·2	55 35·5
	C. St. John, Gull I., lt. Occ. 525f.	50 0	55 21
	Toulinguet Is., lt. Rev. 335f....	49 41·3	54 47·5
	Seldom-come-by Harbour, Cann I., lt. F 85f.	49 35	54 10·7
	Offer Wadham, lt. F 100f.......	49 35·7	53 45·0
	Fouk I., 46f.	49 45·5	53 10·7
	C. Freels, Stinking I., lt. Occ.	49 10·5	53 21·5
	Greenspond I., 85f.	49 4·3	53 32·5
	C. Bonavista, lt. Rev. 150f. ...	48 42·0	53 4·5
	Catalina Harb., Green I., lt. F 92f.	48 30·2	53 2·2
	Bonaventure Head	48 16·9	53 23·6
	New Perlican, Bloody Pt	47 55·1	53 21·5
	Baccalieu I., lt. Fl. 380f.	48 9	52 47·5
	Harbour Grace, (lt. F 40f. on beach)	47 41·4	53 12·5
	C. St. Francis, lt. F 123f.	47 48·5	52 47·0
	St. John's (Chainrock Battery)	47 34·0	52 40·7
	C. Race, lt. Rev. 180f.	46 39·4	53 4·3
	C. Pine, lt. F 314f.	46 37·1	53 31·7
	Trepassy Harb., (Shingle neck)	46 43·3	53 22·2
	C. St. Mary, lt. Rev. 300f. ...	46 49·5	54 11·5
	Placentia Harb., lt. F 180f......	47 14	54 1
	Burin Harb., lt. Rev. 430f......	47 0·4	55 8·7
	Laun, Gt. Laun R. C. Church	46 56·5	55 32·0

MARITIME POSITIONS

(147)	Places	Lat. N	Lon. W
S Coast	St. Pierre I., Galantry lt. Fl. 210f.	46°46′0	56°10′0
	Great Miquelon I., C. Blanc, lt. Occ. 103f.	47 6	56 24
	Pass I., lts. F 281f. and 267f.	47 29	56 12
	Burgeo I., Boar I., lt. F 207f	47 36·5	57 35
	La Poile Bay, Ireland I., lt. Fl. 67f	47 38	58 22
	C. Ray, lt. Rev. 130f.	47 37·0	59 18·2
	Cod Roy I., S side of Boat Harb.	47 52·5	59 23·7
W. Coast	C. St. George, (Red I., SE pt.)	48 33·8	59 13·2
	C. St. Gregory	49 23	58 14·5
	Cow Head, (NW extr.)	49 55·3	57 50
	Port Saunders, (NE pt. of entry)	50 38·5	57 18
	Rich Pt., lt. Fl. 130f.	50 41·6	57 24·2
	Ferrolle Pt., (Cove Pt. NE extr.)	51 2·2	57 2·7
	Flower Cove, (Capstan Pt.)	51 18·2	56 44·5
	Green I., (150 fms. from NE end)	51 24·2	56 33·7
	C. Norman, lt. Rev. 138f.	51 38·0	55 54·2
	GULF OF ST. LAWRENCE.		
	Natashquan Pt., S edge, (R. mo. $\frac{6}{16}$ 4m)	50 6	61 44
	Mingan Is., EW 15 l., Bowen rks., E extr.	50 14	63 1
River St. Lawrence ⊕	Collins' shl., $\frac{12}{2}$ 2m., 7, S pt.	50 10	63 5
	Clearwater Pt., SW extr.	50 12·6	63 27
	Perroquets, lt. Rev. 87f.	50 14	64 11
	Riv. St. John, entr. E pt.	50 17	64 20
	Seven Is., lt. F 200f.	50 6	66 23
	Grt. Cawee I, [¾m.], 250f.	49 50·7	67 1
	Egg I., lt. Rev. 70f.	49 38	67 10
	Pt. Monts, lt. F 100f.	49 19·7	67 22
	Quebec ⊞, NE bastion	46 49·1	71 13·7
	QUEBEC OBSERVATORY	46 48·5	71 13·2
	Wolfe & Montcalm's Monument	46 48·0	71 13·5
	Green I., lt. F 60f.	48 3·4	69 25
	C. Chatte, lt. Rev. 120f.	49 6·0	66 46
	St. Anne's Mounts, NE one, 3973f.	48 52	66 49
	C. Magdalen. lt. Alt. 147f.	49 15·6	65 19
	C. Gaspé, lt. F 350f.	48 45·2	64 9
	Douglas town, ⊞, w	48 46	64 23
Anticosti ⊕	Anticosti I., $\frac{6}{16}$ 41 l., E pt., or Heath Pt., lt. F 110f.	49 5·4	61 42
	Bagot Bluff, lt. Fl. 75f.	49 4	62 15
	Shallop Creek, ⊞, entr.	49 9	62 35
	South-west pt., *l*. lt. R 100f.	49 23·8	63 36
	Ellis Bay, ⊞, W entr., or C. Henry	49 47·8	64 23·5
	West point, lt. F 112f.	49 52	64 32
	Bonaventure I., [1½m.], ⊥, 250f., ‖ E	48 29	64 10
	Leander shl., [¼m.], ꞩ	48 25	64 18
	Macquereau Pt.	48 12	64 48
	Chaleur B., Carlisle	48 1	65 16
	— Dalhousie I. lt. F 30f.	48 4·4	66 22·2

(148)	Places	Lat. N	Lon. W
	Miscow I., $\frac{12}{2}$ 8m., NE pt., Pt. Birch, lt. F 79f.	48° 1′	64°29′
	Miramichi B., Portage I., $\frac{12}{2}$ 4m., S pt., lt. F 45f.	47 10	65 3
	Pt. Escumenac, lt. F 70f.	47 5	64 48
	Richibucto Harb., ⊞, mo.	46 42	64 51
	Fort Monckton	46 3	64 4
	Prince Edward's I., $\frac{6}{16}$ 33 l., N Cape, lt. R 80f.	47 4	63 59
	— Richmond B., ⊞, Royalty Pt.	46 34	63 43
	— East pt., lt. R 100f.	46 27	61 58
	— Charlotte town, St. Peter I., lt. F 70f.	46 7	63 10
Magdalen Is. ⊕	Magdalen Is., $\frac{4}{2}$ 19 l.		
	— Bird Is., 2, [7c.], E one 140f.	47 51	61 9·7
	— Bryon, or Cross I., $\frac{6}{16}$ 4m., w, E pt.	47 48	61 25·2
	— East I., E extr.	47 37·7	61 24·5
	— Doyle rf., [3c.], 3, δ	47 35	61 15
	— Entry I., [1½m.], 580f., r̂.	47 17	61 42
	— Amherst I, 550f., w, b̂, S pt., lt. Alt. 107f.	47 13	61 57
	— Deadman I., [3c.], ⊤ W, rf. E.	47 16	62 14
	St. Paul I., $\frac{12}{2}$ 3m., 450f., w SW, lt. at N pt. F 140f.	47 14·0	60 8
	C. Breton I, $\frac{12}{2}$ 33 l., C. North, lt R 74f.	47 2	60 23
	St. Ann's Harb., ⊞, w. Beach Pt, lt. F 24f.	46 17	60 32
	Sydney Harb., ⊞, lt. at E side, entr., F 70f.	46 16	60 7
C. Breton I.	Scatari I., EW 2 l., δ E, NE pt., lt. R 90f., δ 2m.	46 2	59 40
	Louisburg, ⊞, w, b̂, lt. F 120f.	45 53	59 57
	C. Portland	45 50	60 6
	Madame I., EW 9m., S pt.	45 28	61 3
	Port Hood, ⊞, w, b, Juste-au-Corps I., at entr.	46 0	61 36
	C. St. Lawrence	47 2	60 38
	NOVA SCOTIA.		
	Sable I., EW 7 m., E end, lt. F 12·f.	43 58	59 46
	NW bar, NW extr., ꞩ	44 1	60 38
	Pictou Harb., ⊞$_{13}$, lts. 2 F... ⊕	45 41·5	62 40·2
	C. St. George, lt. R 350f.	45 53	61 55
	Gut of Canso, NW entr., lt. F 110f.	45 41·8	61 29·5
	C. Canso, Cranberry I., 2 lts. F vert. 89f. and 54f.	45 20	60 55
	White Head I., S pt., lt. Fl. 55f.	45 12	61 8
	Country Harb., ⊞, Green I., lt F 51f.	45 6	61 32
	Wedge I, lt. F 81f.	45 1	61 53
	Liscomb Harb., ⊞, I. lt. Alt. 64f.	44 59	61 58
	Ship Harb., ⊞, Briers' I., w, b, Bear rk. 8f.	44 44	62 45
	Brig rk., 9f., ⊤	44 38	62 57
	Pollock rk., [⅓c.], 21f.	44 33	63 5
	HALIFAX, ⊞, [b], Dkyd. tablet	44 39·7	63 35·2
	Sambro I., lt. F 115f., δ 2m.	44 26·3	63 33
	Pennant Pt.	44 27	63 37

MARITIME POSITIONS

(149)	Places	Lat. N	Lon. W
	Margaret's B, ⚓, Shut-in I.	44° 34′	63° 54′
	Tancook I.	44 29	64 6
	Malagnash Harb., ⚓, Cross I., [$1\frac{1}{2}$m.], lt., 2 lts. Vert. dist. 34f	44 20	64 7
	C. La Have, ⊥, 107f., (Black rk. 1m.)	44 12	64 18
	Coffin I., lt. R 65f.	44 2	64 38
	Little Hope I., [2c.], 21f.	43 49	64 45
	Gull rk., lt. F 56f.	43 39	65 6
Nova Scotia	Shelburne Harbour, ⚓, M'Nutt's I., SE pt., ⊥, r, w, 2 lts. F vert. 120f. and 65f.	43 37·5	65 16
	Brazil rk., [3 yds.], 9f.	43 22	65 25
	C. Sable, (SE pt. of small I., *l*, ⚘, W end advancing 1m. in 4 years), ⊥, δ 3m., lt. R 53f.	43 23	65 37
	Blonde rk., small, δ	43 20	65 57
	Seal I., [2m.], S pt., δ $1\frac{1}{2}$m., ⚘, lt. F 98f.	43 24	66 1
	Tusket Is. Pubnico Harb., ⚓ r, w, b, entr.	43 37	65 52
	C. Fourchu, *h*, ⚘ₒ, lt. R 117f.	43 47	66 9
	Lurcher rk., δ, small, 12f.	43 52	66 25
	C. St. Mary	44 7	66 11
	Bryer's I., $\frac{14}{4}$ 4m., lt. F 92f.	44 16	66 22
	Annapolis Harb., ⚓, Pt. Prim, lt F 76f.	44 42	65 47
	Black rk., pt., lt. F 45f.	45 10	64 46
	Haute I., w, ⚓. lt Int. 365f.	45 15·1	65 1
	C. Chignecto, *h*, ⊤	45 19	64 57
New Brunswick, Bay of Fundy	C. Enragé, lt. F 120f.	45 36	64 47
	Quaco, lt. R 110f.	45 19·5	65 32
	Quaco ledge, [1 l.]	45 14	65 20
	C. Spencer	45 12	65 55
	St. John's, ⚓, Partridge I., lt. F 119f ⊕	45 14·1	66 3·5
	C. Lepreau, lt. F 80f.	45 3·7	66 28
	Wolf Is., $\frac{12}{2}$ $3\frac{3}{4}$m., ⊥ ⊤, 100f., Northst.	44 59·5	66 41
	Etang, harb., ⚓, tower S pt	45 4	66 49
	St. Andrew's, ⚓, N pt., lt. F. 42f	45 4·3	67 3
	Campobello I., N pt., lt. F 64f.	44 58	66 54
	UNITED STATES.		
	Quoddy Hd., lt. F 133f.	44 49	66 57
	Old Proprietor shl., [$\frac{1}{3}$c.], rf	44 30	66 37
	Grand Manan, $\frac{12}{2}$ 14m., w, r, ‖ W, δₒ NE pt.	44 46	66 43
	Gannet rk., lt. Fl. int 66f.	44 31	66 47
	Libby I., off Machias B.	44 32·5	67 22
	Machias Seal Is., 2 lts. F 66f. and 54f.	44 30	67 6
Maine	Nash's I., entr. Pleasant R., lt. F 47f.	44 28	67 45
	Petit Manan, S pt., lt. F, Fl. 125f. (δ 2 to 5m.)	44 22	67 52
	Baker's I., lt. Fl. 105f.	44 13·5	68 12
	Castine, lt. F 130f.	44 23	68 49

(150)	Places	Lat. N	Lon. W
	Owl's Head, lt. F 105f.	44° 6′	69° 3′
	Mt. Desert rk. lt. F 75f.	43 58	68 8
	Cashe's Ledge, *T* ⊤, 4 [1m]	42 56	68 51
	I Haute, $\frac{12}{2}$ 5m., Saddleback ledge, 10 E-d., lt. F 51f.	44 1	68 44
	Matinicus I and rks, [4m], lt. on rk., F 90f.	43 47	68 51
Maine	White Head, ⊥, lt. F 79f.	43 59	69 7
	Monhegan I., [1m.], ⊤, lt. R 175f.	43 46	69 19
	Pemaquid Pt., lt. F 75f.	43 50	69 30
	Burnt Island., lt. F 61f	43 49	69 38
	Seguin I., lt. F 180f.	43 41·6	69 46
	Cashe's ledge, 4, [$\frac{1}{4}$m]	42 50	69 4
	Portland, ⚓, City Hall	43 39·2	70 15·2
	— lt., W entr., F 101f.	43 37	70 12
	C. Elizabeth, 2 lts, [300 yds.], F, Fl. and F 143f.	43 33·6	70 11·5
	Wood I., entr. Saco Harb., lt. F, Fl. 63f.	43 27	70 19
	Agamenticus Hills	43 13	70 41
	C. Porpoise, Goat I, SW part, lt. F 38f.	43 21	70 26
	Bald Head	43 13	70 34·5
	Boon I., [$\frac{1}{4}$m.], *l*, lt. F 133f.	43 7	70 29
	York Harb., ⚓ $\frac{21}{12}$	43 9	70 39
	Whale's Back, lt. F, Fl. 65f.	43 4	70 42
	Portsmouth, Fort Constitution, lt. F 70f.	43 3·5	70 43
New Hampshire	Is. of Shoals, [3 m.], S or White I., lt. R 87f.	42 58	70 37
	Newbury Port, ⚓, bar 8f., 2 leading lts. F on N pt. of Plumb I., movable	42 48·5	70 49·0
	Ipswich Bay, lt. F, Fl. 50f.	42 41	70 46
	Annisquam Harb., ⚓, lt. F 50f.	42 39·8	70 41
	C. Ann, lts. NS, on Thatcher I., 2 lts. F 165f. (Salvages N-d., 2m.)	42 38·4	70 34·7
	C. Ann Harb., ⚓, lt. on Ten-Pound I., F 49f.	42 36	70 40
	Salem, ⚓, City Hall	42 31·5	70 54·0
	Baker's I., [$\frac{1}{3}$m.], 2 lts. F 87, 50f.	42 32·2	70 47·5
	Marblehead, lt. F 43f.	42 30·2	70 50
	St. George's shls., EW 7 l., SW, or shl. part, 3.	41 43	67 47
	Little George's, [5]	41 15	68 0
	Boston, ⚓, Cambridge Obs.	42 22·8	71 7·7
	— N side, main outer entr., lt. R 111f.	42 19·7	70 53·7
	Plymouth, ⚓, Gurnet lts., 2 F 93f.	42 0·2	70 36·2
Massachusetts	Barnstable, ⚓ $\frac{17}{7}$, bar., lt. F 33f.	41 43·2	70 16·5
	Billingsgate I., lt. F 52f.	41 51·6	70 4·5
	Race Pt., lt. F, Fl. 51f.	42 3·7	70 15
	C. Cod, high, or Truro, lt. F 195f.	42 2·4	70 4
	Nausset, 3 lts. F 93f.	41 51·6	69 57·2
	Chatham Harb., 2 lts. F 80f., S one	41 40·3	69 57·2
	Monomoy Pt., lt F 41f.	41 33·6	70 0·0

MARITIME POSITIONS

	(151) Places	Lat. N	Lon. W
Massachusetts	Nantucket I., EW 5 l., (shls. "Rips." E-d. 4 l.), N, or Sandy Pt., lt. F 70f.	41° 23′	70° 3′
	— Brant Pt., town, lt. F 43f.	41 17·5	70 5·2
	Nantucket, S shls., old do., ╬ 2¼m., N pt.	41 5	69 50
	— New do., EW 2½m., S pt. 3f.	40 57	69 50
	Martha's Vineyard, EW 6 l., NE pt., or C. Poge, lt. 55f.	41 25·2	70 27·5
	— Holmes Harb., ⊞, W Chop, lt. F 60f.	41 28·8	70 36·2
	— W pt., Gay Hd., lt. Fl. 10ˢ 172f.	41 20·9	70 50·5
	Noman's Laud, [1m.], stat. mid.	41 15·2	70 49·0
	Cuttehunk, lt. F 42f., at S and W pt. of Id.	41 25	70 57
	New Bedford, ⊞, Dumpling, or Round Hill, lt. F 43f.	41 32·2	70 55·7
Rhode I.	Sakonnet Pt., lt. F. Fl. 70f.	41 26·5	71 12
	Bristol, Episcopal Ch.	41 40·0	71 17·2
	Providence, College	41 49·6	71 24·7
	Newport, Court House	41 29·5	71 19·2
	Beaver-tail Pt., or Rhode I. lt., lt. F 68f.	41 27	71 24
	Pt. Judith, lt. R 67f.	41 22	71 29
	Block I., NS 5m., N pt., lt. F 61f.	41 14	71 35
Connecticut	Stonington, town, S pt., lt. F 50f.	41 19·6	71 54·5
	New London, lt. W entr. F 90f.	41 18·9	72 5·7
	Falkner I., lt. F, Fl. 98f.	41 13	72 39
	New Haven, ⊞, lt. F 57f.	41 14·5	72 54·5
	— Yale College	41 18·5	72 56·5
	Norwalk I., lt. F, Fl. 52f.	41 2·8	73 25·5
New York	Long I., $^{15}_{5}$ 34 l., E or Montauk Pt., lt. F, Fl 169f.	41 4·2	71 51·0
	New York, ⊞, City Hall	40 42·7	74 0
	Fire Island, lt. Fl. 168f.	40 37·9	73 12·7
	Fort Tomkins, lt. F 89f.	40 36·0	74 3·5
	Princess Bay, lt. F, Fl. 107f.	40 30·4	74 13·2
	Sandy Hook, 3 lts. F 90f. and 2 beacon lts. F.	40 27·6	74 0·7
	Nevisink, 2 lts., F 248f.	40 23·7	73 59·5
New Jersey	Barnegat Inlet, S side, lt. Fl. (shl. 2m.)	39 45·9	74 6·0
	Little Egg Harb., ⊞, Tucker beach, lt. F, Fl. 52f.	39 30	74 17·5
	Grt. Egg Harb. ⊞, bar, entr.	39 19	74 35
	C. May, (shls. SW), lt. R 167f.	38 55·8	74 58·5
Delaware	Egg I., lt. F 50f.	39 11	75 8
	Cohansey Creek, lt. F 46f.	39 21	75 22
	Philadelphia, State House ⊕	39 57·0	75 9·5
	Reedy I., lt. Fl. 36f.	39 30	75 34
	Bombay Hook, lt. F 46f.	39 21·7	75 31
	Salem, City, Church	39 34·5	75 36
	Mahon's River, lt. F 57f.	39 11	75 24
	C. Henlopen, (δ 2 l. SW), lt. F 128f. ⊕	38 46·6	75 5
	Delaware Breakwater, west end, lt. F, Fl. 47f.	38 47·8	75 6·7

	(152) Places	Lat. N	Lon. W
Virginia	Asseateague I., $^{12}_{2}$ 6 l., *l*, S end, lt. F 153f., shls. off.	37° 55′	75° 21′
	Smith's I., $^{4}_{4}$ 10m., C. Charles (shls. off). lt Fl. 160f.	37 7	75 54
	Baltimore, Battle Monument	39 17·4	76 37·5
	Annapolis, State House	38 58·7	76 29·7
	Pt. Look-out, entrance to Potomac R., lt. F 43f.	38 2	76 19
	Washington, Capitol	38 53·4	77 2·0
	Washington Naval Observatory	38 53·6	77 2·7
	New Pt. Comfort, lt. F 60f.	37 18	76 17
	Back River Pt., lt. F, Fl. 35f.	37 5	76 16
	C. Henry, lt. F 160f.	36 56	76 0
North Carolina	Roanoke Marshes, lt. F 33f.	35 49	75 42
	C. Hatteras, *l*, sand, (shls 3 l. SE), lt. Fl. 191f.	35 15	75 31
	Ocracoke Inlet, lt. N side, F 75f.	35 6·5	75 59
	C. Look-out, shl. $+_{12}$ 3 l., *l*, lt. F 156f.	34 37	76 31
	C. Fear, shl. $+_{12}$ 5 l., Bald Head, lt. F 30f.	33 52	78 0
South Carolina	Georgetown	33 22	79 18
	North I., S pt., ⊞, bar 8f., entr., lt. F 85f.	33 13	79 11
	C. Romain, *l*, $*_{o}$, lt. R 154f., (shl. SE d. 6m.)	33 1	79 22
	Charleston, ⊞, Fort Ripley, lt. F 49f.	32 46·4	79 54
	— Sullivan's I., lt. F 57f.	32 46	79 51
	N Edisto Inlet	32 33	80 12
	Beaufort, Arsenal	32 26	80 41
	Port Royal, ⊞, Paris I., Back lt. F 130f.	32 18	80 40
Georgia	Savannah Riv., ⊞, Jybee I., lt. F 150f.	32 1	80 51
	— Town, exchange	32 4·9	81 7
	Sapello I., north entr. to Doboy Sound, lt. F, Fl. 79f.	31 23	81 17
	Darien, town	31 25	81 33
	St. Simon's I., lt. on S pt., F, Fl. 108f.	31 8	81 23
	Little Cumberland I, $^{12}_{2}$ 5 l., N pt., (entr. St. Andrew's Sound), lt. F 78f.	30 59	81 25
Florida	Amelia I., $^{2}_{12}$ 13m., N pt., (S pt. of St. Mary Inlet), lt. R 112f.	30 40	81 26
	St. John's Riv., $⊞_{6}$, S entr., Jacksonville, lt. F 84f.	30 24	81 25
	St. Augustine (bar), $⊞^{13}_{6}$, N pt. of Anastasia I., lt. F, Fl. 165f.	29 53	81 17
	Musquito Inlet, north side of ent., lt. F 157f.	29 5	80 55
	C. Canaveral, w, north-east pitch, lt. R 139f.	28 28	80 32
	Indian Riv. Inlet, entr. w′	27 33	80 23
	Jupiter Inlet, entr., lt. F & Fl. 146f.	26 57	80 5
	New Riv. Inlet, fort	26 9	80 3
	C. Florida, Fowey rocks, lt. F 111f.	25 35	80 6

MARITIME POSITIONS

Region	(153) Places	Lat N	Lon. W
Florida	Carysfort rf., lt. R 106f.	25° 13'	80° 12'7
Florida	Tavanier Cay, δ 1 l.	25 0	80 30
Florida	Lower Matacumba I., 4/4 3m., W pt. (w''' N)	24 49	80 44·5
Florida	Sombrero Cay, lt. F 144f	24 37 5	81 6·7
Florida	Sand Cay, lt. F, Fl. 110f.	24 27	81 52·7
Florida	Cay West, NW pass., lt. F 50f.	24 37	81 54
Florida	— Cay West, U.S. Naval Storehouse	24 33·4	81 48·5
Florida	Tortugas EW 9m., shls. W 4l., ⚹; Wpt., Fort Jefferson, lt. F 65f., (δ 6m.) ⊕	24 38	82 53
	BAHAMA ISLANDS.		
Bahama Is.	Matanilla, shl. [2], T	27 22	79 4
Bahama Is.	Memory rk., [½c.], 14f.? T	26 57	79 7
Bahama Is.	Bahama I., EW 22 l., W, or Seulement Pt., ⚹	26 41	79 0
Bahama Is.	— "South-east" Pt. (so called), [‡] 10, w	26 28	78 40
Bahama Is.	Grt. Abacou I., 2/12 23 l., lt. near S pt., R 160f.	25 51·5	77 11·2
Bahama Is.	— East Pt.	26 20	76 59
Bahama Is.	Elbow Cays, ⚹, lt. F 123f.	26 31	76 58
Bahama Is.	Great Bahama Bk., 4/4 110 l., Grt Isaac rk., [¾m.], 40f.	26 2	79 5
Bahama Is.	Bemini Is., [7m.], l, ⚹, SW pt., w	25 41	79 20
Bahama Is.	Gun Cay, lt. R 80f.	25 34·5	79 19
Bahama Is.	Orange Cays, ld., [¾m.], 13f., ⚹ₒ, r	24 56	79 9·0
Bahama Is. and Banks	Cay Guinchos	22 45	78 8
Bahama Is. and Banks	Lobos Cay, T, lt. F 146f.	22 22·8	77 35 5
Bahama Is. and Banks	Diamond Pt., 2/1 T	22 10	77 20
Bahama Is. and Banks	St. Domingo Cay, 15f., 1 ⚹	21 42	75 45
Bahama Is. and Banks	Cay Verde, 72f.	22 1	75 11·5
Bahama Is. and Banks	Grt. Ragged I., beac. hill 115f.	22 11·5	75 44·2
Bahama Is. and Banks	Water Cay, [1½m.]	23 0	75 44
Bahama Is. and Banks	Long I., 2/12 19 l., l, ⚹, T, N pt.	23 41	75 19
Bahama Is. and Banks	— South pt.	22 51	74 51
Bahama Is. and Banks	Cay Sal bank, N. Elbow, lt. F 96f.	23 56 5	80 28
Bahama Is. and Banks	Exuma I., 5/5 8 l., entr. harb. ⊞	23 33	75 48
Bahama Is. and Banks	Eleuthera I, 2/12 22 l., ⚹, T, S pt.	24 38	76 9
Bahama Is. and Banks	— NE, or Palmetto Pt.	25 9	76 9
Bahama Is. and Banks	— N pt., hill, (shls. E and W 3 l.)	25 35	76 44
Bahama Is. and Banks	Egg and Royal Is., West I.	25 30	76 55
Bahama Is. and Banks	New Providence I., EW 5 l., Nassau, ⊞ n/17, lt. F 68f.	25 5·6	77 22·2
Bahama Is. and Banks	— E pt., Goulding Cay, w SW	25 7	77 36
Bahama Is. and Banks	Green Cay, [2m.], w'	24 3	77 11
Bahama Is. and Banks	Andros I, 2/12 32 l., Mastic Pt.	25 4	77 57
Bahama Is. and Banks	Berry Is., NS 9 l., T, w, r, E lim., or Frozen Cay	25 32·5	77 42
Bahama Is. and Banks	Great Stirrup Cays, r, lt. F 81f.	25 49 7	77 54
Bahama Is. and Banks	Little Salvador, 5/5 5m., W pt.	24 36	75 59
Bahama Is. and Banks	St. Salvador, 2/12 14 l., NW pt.	24 41	75 46
Bahama Is. and Banks	— East pt. (*Columbus's landfall*)	24 8	75 17
Bahama Is. and Banks	Concepcion [and rks. 2 l.], δ, l, ⚹, T, Id. W pt.	23 50	75 8
Bahama Is. and Banks	Watling's I., 2/2 5 l., Dixon Hill, lt. Fl. 165f.	24 6	74 26
Bahama Is. and Banks	Rum Cay, EW 3 l., wwₒ, S pt.	23 37	74 50
Bahama Is. and Banks	Mira por vos, 2/12 3 l., δ, NE rk.	22 6	74 28
Bahama Is. and Banks	Crooked I., 4/4 14 l., ‡ 4/-, wwₒ, S pt., Castle I., lt. F 123f.	22 6	74 20·5
Bahama Is. and Banks	— Bird Rock, lt. R 120f.	22 50 5	74 23

Region	(154) Places	Lat. N	Lon. W
Bahama Is. and Banks	Samana, or Attwood's Cay, ⚹, T, W pt.	23° 5'5	73° 49'
Bahama Is. and Banks	Plana Cays, EW 10m., l, ⚹, T, hill, W pt., ‡. |ₒ w'	22 35	73 38
Bahama Is. and Banks	Mariguana I., rf. EW 10 l., l, ⚹, T, β, Centre hill, 110f.	22 23	72 55
Bahama Is. and Banks	Hogsty rf., EW 5m., T, δ, NW Cay	21 40·5	73 50·7
Bahama Is. and Banks	Grt. Inagna, 16/6 15 l., l, ⚹, lt. R 120f	20 56	73 41
Bahama Is. and Banks	— Man of War B., W s.de, well	21 4	73 39
Bahama Is. and Banks	Little Inagua, EW 3 l., N pt.	21 33	73 0
Bahama Is. and Banks	Caicos bk., 4/4 22 l., S rk.	21 3	71 45
Bahama Is. and Banks	— West Caicos, 2/2 7m., S pt.	21 37	72 30
Bahama Is. and Banks	— East Harbour, wat. pl.	21 31	71 32
Bahama Is. and Banks	Turk's Is., 2/2 6 l., N extr., lt. Fl. 108f.	21 31	71 8
Bahama Is. and Banks	— Hawk's Nest, wwₒ, ‡ ‡ₒ ⊕	21 26 3	71 10·5
Bahama Is. and Banks	Endymion rk., 4 f.	21 7	71 18
Bahama Is. and Banks	Square Handkerchief, EW 30m., NE breaker	21 6·5	70 29
Bahama Is. and Banks	Silver bk., 2/12 15 l., Cay, SW rk.	20 18	69 58
Bahama Is. and Banks	— North rks.	20 53	69 55
Bahama Is. and Banks	— Eastern edge, 12, T	20 35	69 22
Bahama Is. and Banks	Bajo Navidad, 2/2 7 l., N pt. 17, T	20 13	68 52
	CUBA.		
North Coast ⊕	Cuba, 6/5 217 l., E pt., C. Maysi, lt. F 128f., l, rf. 1m.	20 15·2	74 9
North Coast ⊕	Barracoa. fort	20 21	74 28·5
North Coast ⊕	C. Moa, Cay, ‡'	20 41	74 53
North Coast ⊕	Pt. Lucrecia, lt. R 112f.	21 5	75 36·5
North Coast ⊕	Port Naranjo, ⊞, W pt., h, ⊥	21 6	75 50
North Coast ⊕	Port del Padre, ⊞	21 17	76 25
North Coast ⊕	Pt. Maternillos, lt. R 176f.	21 40	77 8·7
North Coast ⊕	I. Guajaba, 4/4 10m., W pt.	21 55	77 36
North Coast ⊕	Cay Confites	22 12	77 39
North Coast ⊕	Cayo Romano, 2 Is., 4/4 16 l., NW pt.	22 27	78 19
North Coast ⊕	Minerva Cay, [1m.]	22 19	77 48
North Coast ⊕	Cay Sal, bk., 5/5 20 l., 4, Cay Sal, [1m.], w, ⚹, N pt.	23 41·7	80 25·0
North Coast ⊕	— Elbow Cay, lt. F 96f.	23 56·5	80 28
North Coast ⊕	— Dog rks., 4/4 5m., E pt.	24 2	79 51
North Coast ⊕	— Anguilla Is., 4/4 7m., wₒ, S pt.	23 29	79 32
North Coast ⊕	Nicolao rf., Medano I, S-d.	23 12	80 21
North Coast ⊕	Bahia de Cadiz, lt. R 175f.	23 12	80 30
North Coast ⊕	Piedras Cay, lt. F, Fl.	23 14·2	81 8·7
North Coast ⊕	Matanzas, Bay, ‡, S. Severmo Castle	23 3	81 37
North Coast ⊕	Pan de Matanzas, 1277f.	23 1·9	81 45
North Coast ⊕	Havana, ⊞, Morro lt. R 144f.	23 9·4	82 21·5
North Coast ⊕	Managua Paps, 2, EW 2m., 732f., W one	22 57	82 22
North Coast ⊕	Port Mariel, ⊞, entr.	23 3	82 44
North Coast ⊕	Bahia Honda, ⊞ Cerro Morillo	23 0	83 11·7
North Coast ⊕	Pan de Guaijaibon, 2532f.	22 48	83 24
North Coast ⊕	Colorados rfs, rks., δ, T, W pt.	22 9	84 48
North Coast ⊕	W extr., C. St. Antonio, l, ⚹, T, rky., (shl. 4/- 7m., 10), lt. R 128f.	21 53	84 57 2
North Coast ⊕	C. Corrientes, l, sand, ⚹	21 45·5	84 31
North Coast ⊕	Pt. Piedras	22 2	83 50 5
North Coast ⊕	Cays of San Felipe, SW part, T, 1½m. ⊙	21 55	83 32

MARITIME POSITIONS

(155)	Places	Lat. N	Lon. W
Cuba S. Coast O	I. of Pines, EW 16 l., S pt. ...	21° 24'4	82° 56'
	Rosario Channel, ₃, S ent.	21 37	81 55
	Jardines, w̄''', E extr............	21 39	81 2
	Cay de Piedras, lt. F 27f.	21 58	81 3
	Placer de Xagua, [3m.], ₃ ...	21 37	80 35
	Batavano............	22 43	82 18
	Xagua B., ⊞, lt. F, Fl. 82f. ...	22 1	80 30
	Trinidad, mole	21 42	79 59
	Cayo Blanco, 20f.	21 36·6	79 53·5
	Manzanillo ....○	20 20	77 10
	C. de Cruz, rf. 2m., T, lt. F, Fl. 114f.	19 49·9	77 45·5
	Tarquino Pk., 8,400f............	19 56	76 45
	SANTIAGO DE CUBA, ⊞, r, w, lt. F, Fl. 228f., Morro Castle........................	19 57·4	75 52·2
	— BLANCA BATTERY...........	20 00·3	75 50·5
	Guantanamo, or Cumberland Harb., ⊞, E head	19 55	75 11
Caymans	Cayman Brack, ⅙ 3 l., ✱, E pt.	19 45·2	79 44
	Litt. Cayman, ⅙ 7m., l, 3 ✱, E end	19 42	79 58
	Grt. Cayman, EW 6 l., l, ✱, ✱, ⚓ ⚓₀, w̄₀, r, town, ⊕ Fort George	19 17·7	81 23·5
	— East pt., ✱, β 1m...........	19 19	81 7
	JAMAICA.		
Jamaica	Jamaica, ⅙ 43 l., E pt., or Pt. Morant, lt. R 115f..........	17 55·1	76 11·7
	Port Antonio, 2 ⊞, w, fort, lt. F 54f.	18 11·3	76 27
	St. Ann's B., ⊞, Long wharf, w	18 26·4	77 13·7
	Falmouth Harb., ⊞[16], har, fort	18 30·6	77 40
	Montego B., fort...............	18 29·4	77 56·5
	Lucia Harb., ⚓, fort, E entr....	18 28	78 10·7
	Pedro Pt............................	18 28	78 14
	N. Negril, N pt..................	18 21·4	78 22
	Dolphin Hd., pk., 1820f.	18 23	78 11
	S. Negril Pt.	18 16·8	78 23·5
	Savannah la Mar, fort, shl. 2m.	18 12·3	78 8·7
	Pedro Bluff, 220f.	17 51	77 45·2
	Alligator rf. ⅙ 3m., W pt. ...	17 48·5	77 33·5
	Portland Pt., SE pt.	17 43	77 10
	Old Harbour, ⊞. Careening I..	17 53·5	77 5·5
	PORT ROYAL, ⊞, ⊡, F. CHARLES	17 56·0	76 50·7
	Yallah's Pt., (hill 2400f. ✱ 3m.)	17 52	76 33·5
	Port Morant, ⊞, Leith Hall...	17 53	76 21
Pedro Bank and Is. S Weard	Morant Cays, ⅙ 1 l., ✱, δ₀ 2½m., ⚓'NW, NE Cay, ✱, 7f.	17 25	75 59
	Pedro Bk., EW 31 l., SW rock	16 48	78 13
	— NW edge, ₂₆	17 36	78 52
	— Portland rk., E edge, 32f. [2c.], 15f, ⚓ ⚓₀ 8 E......	17 6	77 26
	Baxo Nuevo, EW 5 l, NE pt.	15 53	78 34
	Swan Is., 2, 4½m., ‖₀, 60f., (W one, r̄, w', ✱), E pt., ⌒, ⊥₀	17 25	83 56
	ST. DOMINGO.		
	St. Domingo, EW 120 l., E pt., C. Engano, (shl. N 3m.)...	18 33·8	68 18·7
	C. Rafael, Mt. Redonda, 2m. inland	19 1	68 55

(156)	Places	Lat. N	Lon. W
St. Domingo, N. Coast	Town of Savana la Mar, fort	19° 3'	69° 22'
	C. Samaná, rugged, h, ⊥ ⌒...	19 18	69 8
	Port Plata, lt. R 137f.	19 47	70 38
	Old C. Français, ⌒	19 40	69 52
	Pt. Isabelle........................	19 57	71 1
	Monte Christi B., ⚓, r̄, w	19 53	71 40
	C. Haytien Harb., ⊞, w, ✱, turret d'Estaing...........	19 46·7	72 11·7
	Acul, ⊞	19 45	72 22
	Tortuga I., ⅙ 7 l., E pt., l ...	20 1	72 34
	St Nicolas' Mole, ⊞, w, Fort St. George	19 49·5	73 22·2
	Cape Fou	19 44	73 29
	Gonaives, ⊞, Pt. Verrier	19 25·7	72 42·7
	St. Marcos Pt., h, ⊥	19 2	72 50
	Gonaive I., ⅙ 10 l., ✱, W pt.	18 55·4	73 18·2
	Port-au-Prince, r, w', Fort Alexander. lt. F 46f.	18 33·2	72 20
	Rochelois shl., [1 l.], rks., 3f.	18 39	73 13
	Caymites, ⚓, δ ‖ S, 500f. NE pt.	18 39	73 40
	C. Dame Marie, W pt., (w SE 2m.)	18 36	74 27
	C. Tiberon, h, ⌒, T, w, b in bay)	18 22	74 28
	La Hotte mountains, 7400f. ...	18 23	74 3
	Navasa I., [2m.], 300f., T, ✱, ⌒, r̄, mid. N side	18 25	75 2
	Formigas shl., ⅙ 2 l., ₂, N pt	18 35	75 45
	Pt. Gravois.......................	18 1	73 56
	I. Vache, [3 l.], T S, NW pt.	18 6	73 43
	Aux Cayes	18 12	73 46
	C. Jaquemel, ⊞, Wharf	18 13·5	72 33
	Mountain, 8900f.................	18 21	72 0
	C. False	17 45	71 40
St. Domingo, S. Coast O	Beata I., NS 4m., l, ✱, ⚓ NW, NW pt., 80f.	17 36·7	71 32
	Frayle rk., 50f.	17 37	71 41
	Alta Vela, h, T, 500f...........	17 28	71 40
	C. Mongon	17 50	71 14
	Pt. Avarena	18 7	1 0
	Pt. Caldera, or Salinas	18 12	70 36
	Pt. Nisao	18 13	70 0
	St. Domingo, City, ⊞[13], Consulate, lt. R 111f.......	18 28·2	69 52
	I. Saona, EW 4 l., ✱, Cana Pt.	18 4	68 32
	Mona I., EW 6m., (⌒, w, W end, b̄, rfs. 2m.), 175f., C. San Juan	18 3	67 51
	Desecho I., [1m.], T, ✱, vis. 12 l	18 22·7	67 29·2
	PORTO RICO.		
Porto Rico	Aguila Pt., lt. R 128f............	17 58	67 15
	Shoals 2 l. off W coast, Bajo Gallardo, [1]	18 0	67 21
	B. of Mayaguez, lt. F	18 13	67 10
	Aguadilla B, lt. Fl., r, w''' ...	18 28·5	67 11
	PORTO RICO, ⊞. MORRO, lt. R 174f.	18 28·9	66 7·5
	NE extr., or C. Juan, (rks.), lt. F, Fl. 266f..............	18 23	65 36
	Anvil, 3700f.	18 19	65 47
	SE pt., C. Mala Pasqua.........	17 59	65 49
	Caxo de Muertos I., [1m.], (⚓ W 8), S rk., lt. F, Fl. 297f.......................	17 53	66 34

MARITIME POSITIONS

Group	(157) Places	Lat. N	Lon. W
	Port Ponce, lt. Fl. 39f.	17° 58′	66° 40′
	Pt. Guanica	17 56	66 57
	CARIBBEE ISLANDS.		
Virgin Islands	Culebra, or Passage I., 6/5 7m, (⊞ SE. w, r̄, b), Culebrita I., lt. F 305f.	18 19	65 14
	St. Thomas I., 6/5 4 l., ⊞, [b]. r, lt. F 95f., E entr., Fort Christian	18 20·4	64 55·7
	Frenchman's Cap, 195f.	18 14	64 51
	St. John's I., EW 3 l., Ram Hd	18 18·1	64 42
	Norman I., 440f., Man of War B., on W side. ⊞. N pt.	18 20	64 37
	Tortola, 6/5 10m., ab. 1780f. Town, ⊞, ẇ, r, Fort Burt Pt.	18 25·1	64 36·5
	Ginger I., [1m.] 500f., ⊥	18 24	64 28
	Virgin Gorda, 4/4 3 l., pk 1370f., East pt.	18 31	64 18·5
	Anegada, 6/5 3 l., *l*, ⚓. δ, (1f. SE 3 l.), W pt., w, 30f.	18 45	64 24·7
St. Croix	Sta. Cruz, 6/5 7 l., 1184f. ẇ, b̊, E pt.	17 45	64 34
	— Christianstœd, ⊞. Lang's Observatory, Transit pier, lt. F	17 44·7	64 41·2
Leeward Islands	Sombrero, [3/4m.], *l*. T, w₀, ⌒, 37f., ⚓₀, lt. R 150f ⊕	18 35·6	63 27·7
	Dog I., [& rks. 2½m.], W rk. ⊕	18 16·7	63 15·5
	Anguilla, 6/5 14m., 213f., w₀, Cust. ho. ⊕	18 13·2	63 4·2
	St. Martin I., EW 8m., w₀, r, b, sum. 1361f.	18 5	63 3·2
	— Fort Marigot, lt. F 66f. ⊕	18 4·1	63 5·5
	S. Bartholomew, 6/5 5m., N pk. 992f.	17 54·3	62 48·5
	Saba [3m.]. *h*, T, 2820f.	17 38	63 14
	St. Eustatius, 4/4 4m., *h*, 1950f., Fort fl. st.	17 29·2	62 59
	St. Christopher, 4/4 6 l., ẇ, r, Mt. Misery. 4313f.	17 22	62 48
	— St. George's Ch., lt. F 37f.	17 18	62 43
	Nevis, [2l.], ẇ, r. 3595f sum.	17 12	62 33
	— Charleston, SW pt., ẇ	17 8·8	62 36
	Barbuda, 4/4 14m., vis. 6 l., ⚓₀. r, ⚓ SW pt.; S & E pt., δ 1 l., 200f.	17 33	61 43
	— River fort, SW side ⊕	17 35·8	61 49·5
	Antigua, 6/5 12m. (δ N), 1330f. St. John's Cathedral T'	17 6·2	61 50·5
	— English Harb., ⊞, ẇ, [b], Dockyd., flagstaff	17 0·0	61 45·7
	— Boggy's Pk., 1339f.	17 2	61 51
	Redondo, ⚓₀, 600f., ⚓ 1l W, T ⊕	16 55·5	62 18·7
	Montserrat, 2/2 3 l., 3000f., w. T, N pt.	16 49·3	62 11·7
	— Plymouth, ẇ′, ⊥, lt. F 56f.	16 42·2	62 13
	Guadeloupe, [12 l.], 4870f. N pt.	16 21	61 26·8

Group	(158) Places	Lat. N	Lon. W
Guadeloupe	Guadeloupe, Vieux Fort, pt.	15° 57′	61° 42′
	— Basse Terre, Fort Trois ⊕	16 0·5	61 45·2
	— Souffrière, volc., 5500f.	16 5	61 39
	Désirade, 4/4 7m, N pt.	16 21·4	60 58·7
	Petite Terre, lt. F 108f.	16 10·5	61 6
	Marie Galante, 2/2 10m., w W, Grand Bourg, lt. F. 46f.	15 54	61 19
	Dominica, 2/2 9 l., *h*, δ₀ 1m., 4747f., N pt.	15 38	61 26
	— Roseau, town, lt. F.	15 17·4	61 23
	— South pt., *h*, fl. st.	15 13	61 22
	Aves I., [3c.], 10f., w̄ ? ⚓ W	15 42	63 37·7
Martinique	Martinique, 2/2 11 l., Mt. Pelée, 4428f.	14 48	61 10
	— St. Pierre. St. Marthe, Battery. lts. 2 F.	14 43·9	61 11·2
	— Fort Royal. ⊞. lt. F 131f.	14 36	61 4·2
	— South pt. islet	14 24	60 52
	— Caravel rk., 96f., ⚓₀, ⌒	14 48·5	60 53
	St. Lucia, NS 10 l., 4000f., N pt.	14 5	60 57
	— Port Castries. ⊞, Vigie, lt. F 300f.	14 1·5	61 1
	— W pt., 2 Sugarloaves, *blk*, ⚓, vis. 16 l.	13 47	61 5
Windward Is.	St. Vincent I., NS 5 l., 3000f.	13 23	61 11
	— Kingston, Fort Charlotte, lt. F 640f.	13 9	61 13·2
	Bequia I., 4/4 2 l., ⚓′ W, w̄′, Admiralty Bay, r̄, b, N pt.	13 5	61 12
	Grenada, 2/2 5 l., 2749f., (δ₀ 2m), S pt.	11 59	61 42
	— St. George, ⊞, [b], fort, lt. F	12 3	61 45
	Barbados, 2/2 6 l., 1104f., E pt., lt., [b]	13 9·9	59 25·5
	— Ricketts Battery	13 5·7	59 37·2
	— Bridgetown, Engr.'s Wharf	13 5·2	59 36·7
	GULF OF MEXICO.		
Florida	C. Sable, fort	25 7	81 5
	C. Romano, *l*, ⚓, (bk. SW 9m., 3 f.)	25 51	81 42
	Saniabel I., ⊞[12], r, w, b, lt. F, Fl., 98f.	26 27	82 1
	Tampa B., Egmont Cay at entr., lt F 86f. ⊕	27 36·1	82 46
	Anclote Cays, lt. Fl. 100f.	28 10	82 52
	Cedar Cays, Dépot Cay, (shl. 4/4 7m.). lt. F, Fl. 75f.	29 6	83 4
	St. Mark's, lt. E entr. F 83f.	30 4·4	84 10·5
	Dog I., [6m.]. ‖ 3 E, ‖₀ W	29 46·3	84 38·2
	St George I. (Harb. ⊞[10]), C. St. George, lt. F 73f. ⊕	29 35·3	85 3
	C. St. Blas. *l*, (shl 4/4 4m.), lt. Fl. 198f.	29 40	85 21
	Pensacola B., ⊞. Fort Barrancas, lt. Fl 210f.	30 20·8	87 19
	Mobile, ⊞, lt. E entr., R 33f.	30 13·6	88 0·7
	— Choctaw Pt., lt. F 47f.	30 40	88 0

MARITIME POSITIONS

	(159) Places	Lat. N	Lon. W
Mississippi	Ship I., ⊕ 7m., ✝ ; w N, mid. ; W pt., lt. F 54f... ⊕	30°12'6	88°58'
	Cat I., EW 5m., ✝, W pt., lt. F	30 13'7	89 10
	Chandeleur Is., ⊕, l, w, b, SW, lt. N pt., F 58f.	30 3	88 53
	Mississippi Riv., NE pass., Frank's I.	29 11'5	89 0
	— South Pass, lt. Fl. 108f.	29 1	89 10
	— SW Pass, lt. F 128f.	28 58'5	89 23'5
Lousiana	New Orleans, City Hall	29 57'7	90 6'7
	Timbalier I., ⊕ 7m, lt. F, Fl. 111f.	29 3	90 21
	Ship I., shoal, lt. R 115f.	28 55	91 5
	South west reef, lt. F 56f.	29 23	91 30
Texas	Sabine Pass, Texas Pt., bar 8f., mound, lt. Fl. 85f.	29 43	93 51
	Bolivar Pt., lt. F 117f.	29 22	94 45'7
	Galveston I., ⊕ 7 l., l, 3 ✝ mid., NE pt.	29 21	94 45'7
	San Luis Harb., bar 12f., town	29 4	95 6
	Matagorda Bay, bar 8f., lt. F 91f.	28 20'2	96 25
	Aransas Pass, 8f., lt. F 59f.	27 51'5	97 3
	Santiago, Barra de, 7f., lt. F 60f.	26 6	97 10
	Rio Grande, or Bravo del Norte, U.S. Observatory	25 57'4	97 7'2
	MEXICO.		
	Rio Fernando, or Tigre .. ○	25 23	97 20
	Barra de Santander, 6f. ○	23 48	98 43
	Barra del Ciega ○	22 38	97 52
	Cerro del Mecate, 10m. inland ○	22 47	98 3
	Tampico, bar 10f., δ, fl st., lt. Fl. 141f. ○	22 16	97 49
	C. Roxo ○	21 35	97 22
	Lobos I., [¾m.], 35f., ✝, w, r, (rf. N 2m.) ○	21 28	97 13
	Tuspam shl., islets, ⚓ ' 7	21 1	97 10
Vera Cruz	Mexico, city, St. Augustine	19 25'7	99 5
	Vera Cruz, w, rr, San Juan de Ulloa, lt. R 79f.	19 12'5	96 8
	Sacrificios I., [and rf. ⅓m.]	19 10'2	96 5 5
	Orizaba, mount, 17,895f.	19 5	97 15
	Cofre del Perote, Pk., 13,995f.	19 29	97 7
	Alvarado, bar 8f. δ, lt. F 246f.	18 51	95 48
	Tuxtla, volcano	18 30	95 9
	Roca Partida, w, r	18 44	95 3
	Pt. Zapotitlan, l ✝, w''' ○	18 35	94 48
	Goazacoalcos Bar, lt. F 126f.	18 10	94 26
	R. Tabasco, W mo, bar 8f. lt. F, Fl. 77f.	18 38	92 44
	I. Carmen, ⊕ 9 l., W end, Port Laguna, entr. of Terminos Lag., ⊞, w, r, b, Brit. Cons., (lt. R 100f.)	18 38'4	91 53
	Champoton, w, b	19 21	90 44
	Lerma, Ch. in square, ⚓, w'	19 48 4	90 30 7
	Campeche, ⚓', w, r, Fort San José, lt. F 95f.	19 50	90 33

	(160) Places	Lat. N	Lon. W
Yucatan	Celestun, lt. F 95f.	20° 53'	90° 24'
	Pt. Palmas, ✝	21 2	90 15
	Sisal, ⚓, w, b, fort, lt. F 60f. ⊕	21 10'1	90 2'7
	Sisal rk., [¾m.], 5f., (Snake and Madagascar shls. NW-d 7 l.) ⊕	21 21	90 10
	Progresso, lt. F 57f.	21 16	89 36
	Lagartos, R. San Felipe	21 34	88 18
	C. Catoche, l, ✝, (N pt. of Jolbos I., ⊕ 6 l.) ⊕	21 36	87 6
	Contoy I., ⊕ 4m., l, ✝, N pt.	21 32	86 49
	Mugeres I., ⊕ 5m. 80f., ⚓ ⚓, w, b, S pt, Stone turret	21 12'7	86 40 5
	Cozumel I., ⊕ 8 l., 70f., ✝, N pt.	20 35'5	86 44'7
	Ascension B., Noja spit	19 37	87 27
Is. &c. in Gulf of Mexico	Areas, [2m.], rks., ✝, W Cay ⊕	20 12'6	91 59'2
	Obispo, shls., 2, ⊕ 5m., 5, N one, beac. buoy	20 28'5	92 13
	Triangles, 3 Is., ⊕ 7m., l, rk., ✝, ~, b, E one ⊕	20 54'9	92 13
	English bank, [5] ⊕	21 47	91 56
	Baxo Nuevo, [2c.], rf., l, δ, beac. 35f. ⊕	21 50 5	92 5
	Cay Arenas, Sandy I., [3m.], l, ~, beac. 20f., N pt.	22 8	91 23
	Alacranes, ⊕ 5 l., rks., δ, Whale rock	22 35	89 49
	— Port, ⊞, Perez I., [4c.], huts ⊕	22 23'6	89 42 2
	HONDURAS.		
British Honduras	Chinchorro bk., or Northern Triangles, 8 l., Great Cay, N pt.	18 37	87 20
	Ambergris I., or Cay, E or Reef Pt., δ 2m.	18 6	87 50
	— S pt.	18 23	87 23
	Lt. ho reef, ⊕ 10 l., SE pt, Half Moon Cay, ✝ l., F 88f.	17 12	87 33
	Turneffe, rfs., ⊕ 10 l., Mauger Cay, 3 lts. F 53f., 49f.	17 36	87 46
	Glover rf., ⊕ 5 l., S pt	16 41	87 53
	Belize, ⊞, Fort St. George, w, lt. F 43f.	17 29'3	88 12
	Dolphin Hd., 5m. inland	17 17	88 24
	Cockscomb Mt., 4000f. ⊖	16 48	88 38
	Pt. Icacos, (w N ¾m.) ⊕	16 14 3	88 36
	R. Dulce, entr., W pt.	15 49	88 47
	C. Three Pts., l, ✝, (shls. 4 or 5 l.), NW pt., w,	15 58	88 39 5
	Omoa, St. Fernando, fort ⊕	15 47'2	88 37
	Saddle hill, 1760f. ⊕	15 45'0	87 58
	Sal rocks, pt.	15 55	87 38
	Cangrejo Pk., 8040f.	15 38	86 53
	Truxillo, fort	15 55'7	85 59'5
	C. Honduras, or Castilla, l	16 2	86 4
	Utilla I., ⊕ 7m., δ, NE pk. ⊕	16 7'5	86 52'7
	Salmadina shl., [1m.] ⊕	15 54	87 4
	Hog Is., [1 l.], highest hill on W. I. ⊕	15 58	86 32'7
	Rattan I., ⊕ 9 l., ✝, Coxen bay, lt. F	16 18	86 35

MARITIME POSITIONS

(161)	Places	Lat. N	Lon. W
Honduras	Rattan Is., Port Royal Harb., ⊞, w′, r̂, George Cay, N W pt.	16° 24′3	86° 19′2
	Barburet I., δ 1 l. E	16 26	86 9
	Bonacca I., 4/4 3 l., ⊞ NW and SE, h, ⚓, r̄, sum. 1200f.	16 28	85 55
	Misteriosa bk., 6/6 8 l. n, S pt. 18	18 44	84 2
	Swan Is., 2, EW 4m., W one, ⚓, w ✓ r̄, E pt...... ⊕	17 25	83 53
	Poyas Pk., 3700f., 12m. inland	15 44	84 56
	C. Camaron, projecting, *l*	16 0	85 3
	Black R., bar δ, w′, b	15 57	84 56
	Patook R.	15 49	84 18
	Caratasca lag., entr. 8f., E pt ..	15 23·7	83 43
	False Cape, *h*, δ shl	15 13	83 22
	C. Gracias à Dios, *l*, ⚓, w₀, b..	14 59	83 11
Off-lying Islands and Cays	Bank off C. Gracias, N part...	16 48	82 10
	— East extr., 18	15 32	80 56
	Caxones, or Hobbies, 6/6 4l., E pt.	16 3	83 6
	Cay Gorda, [2m.], ⚓₀, (βE-d. 2 l)	15 52	82 24
	Alargate rf., 2/2 10m., E pt. ...	15 7	82 20
	Mosquito Cays, ⚓ 60f., (w W 5m., ⚓ S 4), SE part......	14 20	82 44
	Rosalind bk., SE shl. part, 4, [5m.]	16 8	80 17
	Serranilla bk., Cays, EW 25m. S, beacon Cay, 8f.	15 48	79 51
	Serrana bk., 6/6 6 l., δ, SW Cay, 32f..........................	14 16	80 24
	Quita Sueño bk., rf., NS 8 l., S pt.	14 8	81 9
	Roncador Cay, 4/4 6m., 7f., ✻, w, S pt. ⊤	13 31	80 2
	Old Providence and Catalina Is., [rfs. 5 l.], w′ W, b, r, ⚓ ⚓₀ W, sum. 1190f.......	13 21	81 23
	St. Andrew's I., 2/2 8m., 50f., w‴, r′, SW cove	12 31·7	81 44
	Courtown bk., 2/2 7m., SW Cay, ⚓₀, w.................	12 24	81 29
	Albuquerque Cays, [4m.], ⚓ W	12 10	81 54
Mosquito Coast	Brangman's Bluff, ⚓ 4 S, w, ⌊ .	14 3	83 22
	Rio Grande, bar 6f.	12 54	83 32
	Pearl Lagoon, entr., N pt., (shl.)	12 21	83 38
	Blewfields, ⊞ 15/12, (shifting bar), r, W pt. of bluff......	11 59·3	83 41
	Little Corn I., *l*, ⚓, [1½m.], W pk.	12 17·0	82 36
	Great Corn I., 4/4 2½m., *h*, ⚓, w,, b, r, ⚓ ⚓₀ SW pt., sum.	12 9·2	82 59·7
	Pajaro I., small, 155f.	11 31	83 43
Costa Rica	San Juan de Nicaragua, (called Grey-town, 1848), [⚓], w‴ up riv., b, r ...	10 55	83 43
	Pt. Arenas .... ⊕	10 56·7	83 43·2
	Mt. Cartago, 11,100f.......... ⊕	10 2	83 48
	Pt. Blanco, Grape Cay, E of do., (w W 1m.), lt. F 60f. ⊕	10 0·0	83 2·5
	Carreta Pt., w W 2m.	9 38	82 40
	Boca del Toro, ⊞, fort, w′ 1/6 1m., r₀, b .... ⊕	9 20·5	82 15·2
	Blanco Pk., 11,740f.	9 17	83 4
	Shepherd's Harb., ⊞, Cay, 4/4 2⅓m., White hut ... ⊕	9 14·4	82 20·7
	Zapadilla Cays, 6/6 3m., E pt...	9 15	82 2

(162)	Places	Lat. N	Lon. W
Chiriqui	Chiriqui, lag., ⊞, Chica Mola riv.................. ⊕	8° 59′0	81° 55′7
	Valiente Pk., 722f. .... ⊕	9 10·5	81 55
	Escudo I., 6/6 2½m., *l*, ⚓, w W pt. .... ⊕	9 6·4	81 34·5
	High pk., 5251f., (1/2 6m. of Buppan bluff) ...... ⊕	8 42·7	81 30·0
	Castle Choco, 6342f., 5 l. inland .... ⊕	8 37	80 52
	ISTHMUS OF PANAMA.		
Isthmus of Panama.	Chagre, w riv., rr₀, San Lorenzo, fort .... ⊕	9 19·7	79 59·5
	ASPINWALL, or COLON, lt. F 60f.	9 22·2	79 54·7
	Porto Bello, rr₀, ⊞, Fort St. Jeronymo .... ⊕	9 32·5	79 38·5
	Farallon Sucio, rk	9 39	79 37
	Pt. Manzanilla, *h*, ⊥ .... ⊖	9 39	79 32
	Pt. San Blas, *l*, (rf. 2m.) ... ⊖	9 35	78 58
	Mandinga, ⚓′.............. ...	9 30	78 58
	Muletas Archipelago, E pt. ...	9 37	78 38
	Pt. Musquitos..........	9 8	77 56
	Pinos I., [1m.], *h*, ⚓, NE pt...	9 1·5	77 46
	C. Tiburon, ⊥, *h*, rky., (⚓ 12 W)	8 41	77 21·5
New Grenada	Pt. Caribana, (shl. 4/4 5m.) ...	8 38	76 53
	I. Fuerte, [1¼m.], ⊀⊱, ⚓ ⚓, δ	9 24	76 10·7
	Cispata Harb., ⊞, East pt. Zapote	9 24	75 50
	Santiago de Tolu, E entr.......	9 31	75 38
	San Bernardo Is., [3 l.], *l*, ⚓, Nst. one	9 48	75 53
	Tortuga shls., 2, outer, [7] ...	10 3	75 57
	Rosario Is., [2 l.], Wst. one...	10 11	75 51
	Cartagena, ⊞, Dome......... ⊕	10 25·6	75 34·0
	— Entrance, fort, lt. F 60f. ...	10 19	75 35·2
	Pt. Canoas, *l*, *h*, over, (rks. S W-d. 3m. 5f.)	10 34	75 33
	Pt. Galera, *l*	10 47	75 26
	Port Sabanilla, ⊞, lt. F, Fl. 98f.	11 0	74 58
	Magdalena Riv., bar, ‖₀, b, w,, C. Augusta	11 6	74 51
	Sta. Marta, ⊞, Morro, lt. F 328f ⊕	11 15	74 14·7
	C. Aguja, ⊥, *h*, ⊤, (rks. 3c.)	11 20	74 12
	C. San Juan de Guia...........	11 21	74 0
	Hacha, δ, lt. F 90f.	11 33	72 55
	C. Vela, (islet 2c. off, δ₀), E pt.	12 10	72 12
	Bahia Honda, ⚓′, δ shl. in mid. entr., E pt.	12 19	71 46
	Pt. Gallinas, (shl. 2m.).........	12 25	71 42
	Druid shl., [2], ⊤ E............	12 30	71 39
	Pt. Espada	12 4	71 8
	Zapara Castle.....................	11 1	71 38
	Maracaybo, ⊞ 12, bar, entr., (shifts)	11 2	71 39
	— Town, 20m. up the lake, 10f.	10 41	71 42
	Pt. Arenas	11 7	70 55
	Coro	11 24	69 44
	Pt. Cardon, *l*	11 36	70 18
	C. San Roman	12 11	70 5
	Pt. Manzanilla	11 31	69 20
	VENEZUELA.		
	Monjes, δ₀, N rks.	12 29	70 57
	Oruba I., 4/4 5 l., Port Caballos, lt. F 40f.............	12 29	70 7
	Curaçao I., 4/4 12 l., Mount S. Christoffel, 1200f.	12 19	69 9

MARITIME POSITIONS

	(163) Places	Lat. N	Lon. W
Coast of Venezuela	Curaçao, Rif fort, St. Ann, ⊞	12° 6·3	68° 57′
	Little Curaçao, (2m.], *l*, lt. F 75f.	11 59	68 35
	Buen Ayre I., $\frac{4}{4}$ 6 l., Lucre pt., lt. F 85f.	12 2	68 17
	Aves Is., 2 grps., EW 5 l., W one, [2 l.], ⌐, S Id....	11 59	67 40
	Los Roques, EW 8 l., Port El Roque, N side, ⚓′, w, b, N pt., lt. R 208f.	11 58	66 38·5
	Orchila, [7m.], W pt., rk. 10f.	11 49	66 14
	St. Juan B., Cay St. Juan... ⊖	11 10	68 23
	Tucacas, ⊞, Ore house	10 47	68 20
	Porto Cabello, ⊞, lt. Fl. 82f....	10 29·4	68 2 7
	La Guayra ⚓,, w, r′, Trinchera Bastion, lt. F 300f. ⊕	10 36·9	66 56 5
Caraccas	Caraccas, 3000f., 7m. inland...	10 30	66 57
	Peak, or Silla de Caraccas, 5m. inland, 8500f.	10 32	66 52
	Pt. Maspa, (rks. off)	10 40	66 19
	Centinella, 70f.	10 49	66 9
	C. Codera, *l*, T, (⚓′ W 7, Corsair B.), W pt.	10 36	66 7·5
	Morro of Barcelona, (City $\frac{1}{2}$ 2¼m.)	10 13·5	64 43
Cumana	Cumana, Fort Antonio, w′, lt. F 44f.	10 27 6	64 12
	Pt. Escarseo	10 40	64 16
	Tortuga I., EW 4 l., Oriental Pt.	10 55	65 12·5
	Blanquilla I., NS 2 l., (*l*, ✱₀, δ_0, w W, ⚓ NW), N pt....	11 55	64 37
	Hermanos, $\frac{21}{2}$ 10m., T, δ_0, S rk.	11 42	64 29
	Margarita I., EW 12 l., (N Coast δ_0), N pt., C. Isla	11 10	63 54
	— Pampatar, Castle	10 59	63 49
	— West extr.	10 58·5	64 25
	Sola I., rk. δ	11 19	63 36
	Testigos Is., $\frac{4}{4}$ 2⅓m., δ_0, ⚓ SW 8, w, vis. 5 l., Grt. I.	11 23	63 8
	Carupano B., lt. F 130f.	10 41·2	63 14·7
	C. Three Points, δ_0 ½m.	10 45	62 41
	Peñas Pt., (W pt. of Dragon's Mouth)	10 44	61 51
	Pt. Foletn, mouths of Orinoco R.	10 0	62 18
	Trinidad and Tobago.		
Trinidad	Trinidad, $\frac{14}{4}$ 26 l., E pt., Pt. Galera, *l*, rky.	10 50	60 54
	— Guayguarare Bay	10 9·2	61 1
	— Chacachacare I., [2m.], 830f., E side of Dragon's Mouth), sum. ...	10 41·7	61 45
	— PORT SPAIN, ⊞, fort lt. F 50f.	10 38·7	61 30 7
	— West pt., Pt. Icacos, T, lt. F 39f.	10 3·8	61 55·7
	— SE pt., Pt. Galeota, vis. 6 l.	10 8·2	60 59 2
	Tobago, $\frac{4}{4}$ 8 l., N pt., Marble I.	11 21 8	60 31
	— SW pt., shoal, 6m. SW ...	11 8·6	60 50
	— Rockly Bay, lt. F on E pt...	11 10·1	60 42 4
	GUIANA.		
	Orinoco, E mo., (shls.), Crab I., [3 l.], N pt.	8 42	60 55

	(164) Places	Lat.	Lon. W
		North	
British Guiana	Pt. Barima, lt. v. F, ✱, 50f.	8 30′	60° 23′
	Mocomoco Pt.	8 39	60 10
	R. Guayama entr., (bk. N 6 l., hills to SW-d. inland) ...	8 25	59 57
	Coco Pt., *h*, ☨ ... ○	8 0	59 25
	C. Nassau, E pt. of Paurnma R., (shl.)	7 36	58 56
	R. Essequibo, beacon E of Leguwan I.	7 0	58 18
	— Fort Zealand	6 47	58 32
	R. Demerara, ⊞ $\frac{16}{7}$, bar, beac., (5 or 6 ☨ 9m E-d. in 1834)	6 58	58 14
	Georgetown, lt. R 103f.	6 49·4	58 11·5
	Berbice R., shl., ⊞, bar 7f., Crab I., [1m.], *l*, ✱	6 21	57 30
	— Fort York	6 19	57 32
	Corentyn R., (shls. 3 l.), Nickerie Fort	5 57 5	57 0
French and Dutch Guiana	Coppename R., E pt., entr. ⊖	5 54	55 56
	R. Surinam, Fort Amsterdam...	5 53	55 5 5
	— Paramaribo, Church	5 49	55 9
	Post Orange	5 57	54 34
	R. Maroni, W pt., lt. F 76f. ...	5 44	54 0·5
	Mana R., Establ. on W bk. ...	5 37	53 50
	Salut, or Devil's Is., 3, [¾m.], ⚓ $\frac{1}{4}$, S one, w, lt. F 197f.	5 17	52 35
	Cayenne, ⊞, fort, lt. F 130f...	4 56·5	52 20
	Mother rk., [¾m.], pilot sign...	4 53	52 10
	Gunner's Is., $\frac{16}{6}$ 2m., E, or grt. one	4 50	51 54
	Pt. Behague, *l*, ✱, at E entr. of Apronak Riv.	4 35	51 53
	Argent Mount	4 22	51 39
	C. Orange, *l*, ✱	4 20	51 27
	C. Cachipour, *l*, ✱, NE part..	3 50	51 3
	Mt. Mayé	2 47	50 54
	Maraca I., [3 l.], *l*, Old Cape North	2 15	50 18
R. Amazon	Cabo do Norte ○	1 40	49 57
	Baïlique I., [7m.], N pt.	1 4	49 56
	Macapá, fort	0 0 8	51 2
	Mexiana I., $\frac{12}{6}$ 11 l., 8 W, E pt.	0 0	49 19
	BRAZIL.		
		South	
	Chaves	0 18	49 55
	Frescas I., [2m.]	0 3	48 59
	C. Magoari, NE pt.	0 13	48 20
	PARA, CUSTOM HOUSE	1 27	48 30
	Braganza shl. and bks., $\frac{2}{2}$ 7 l., lt. F 30f.	0 25	47 58
	Salinas, vill., δ	0 36	47 24
	Cajetuba I., N pt.	0 31	47 42
	Aialaia Pt., lt. Rev.	0 36	47 22
	Caite Is., NE part	0 43	46 57
	C. Gurupi, N pt.	0 54	46 14
	Pt. Tamandua	1 16	45 23
	I. St. Joao, $\frac{14}{4}$ 4 l., *l*, w, lt. F 78f.	1 17	44 55
	Itacolomi Pt., ✱, lt. R 147f. ...	2 10	44 24·7
	Maranham, ⊞ $\frac{27}{11}$, w′, r, Cathedral... ☾	2 31·7	44 16 7
	Coroa Grande shl., rks., centre	2 14	43 59
	Fort St. Marcos, lt. F 119f. ...	2 29	44 17

MARITIME POSITIONS

Region	(165) Places	Lat. S	Lon. W
N. Coast	Mancel Luiz shl., rf., [1 l.], T, ββ₀, W rk.	0° 51′	44° 17′
	Silva shl.	0 32	44 19
	I. St. Anna, [7m]. (rfs. 4 l.), ⚓, lt. R 190 f.	2 16	43 38
	Lançoes Grandes, W pt.	2 21	43 22
	Barra Velha, B. Paranahyba, lt. F	2 50	41 44
	Jericoácoará w̄, r, E sand hill	2 47	40 28
	Almufedas, vill., Steeple in †	2 56	39 48
	Mt. Melancias, isolated sand hill	3 12	39 18
	Ceara, Church tower	3 43	38 32·5
	Pt. Macoripe, lt. F 85f.	3 42	38 27
	Jaguaribe R., bar, ββ₀, w, N pt., lt. F	4 25	37 45
	Aracati, town	4 31	37 48
	Morro Tibaõ, red sand hill	4 49	37 18
	Pt. do Mel, ⚓ ? (shls.), N pt.	4 55	36 53
	Pt. Tubaraõ, N sand hill	5 2	36 28
	Ureas, shls., β, T N, N edge	4 50	36 16
	C. St. Roque, l, ⊥	5 30	35 16
Brazil	Rio Grande do Norte, ⊞, Circular Fort on ledge, (w ½m.), lt. F 43f.	5 45	35 11
	Parahyba do Norte Riv., ⊡ 19/7, Pedra Secca, lt. R 52f.	6 56	34 49
	Fort Cabedello, †	6 57 8	34 50
	C Branco. sand, ⊥, (2 † at pt ?)	7 8	34 48
	Pt. de Guia, E extr. of S. Amer.	7 26	34 47
	Olinda Pt., lt. Occ.	8 1	34 50
	PERNAMBUCO, ⊡ 15/9, bar, w′, r, b, Fort Picao, lt. R	8 3·4	34 52
	C. St. Agostinho ⦣, ⚓, Ch. sum.	8 20	34 56
	Mt. Sellada, S pk.	8 25	35 11
	St. Aleixo I., [2c.], w	8 36	35 0
	Tamandaré, ⊞, fort	8 43 4	35 5
	Maceio †, w, fort, (⚓ 2, lt. R 208f.)	9 39	35 39
E. Coast	R. St. Francisco, S, or Samoco Pt., l, ⚓, β 1½m., lt. F 59f.	10 29	36 24
	Itabayana Mts., sum.	10 47	37 23
	Tres Irmaos. 3 mts., 2 l. inland, SE hill	11 16	37 17
	Mt. Masarandupio, 10m. inland	12 24	38 4
	BAHIA, ⊞, [b], C. ST. ANTONIO, lt. R 140f. ⊕	13 0·7	38 32
	Morro St. Paulo, lt. R 276f.	13 23	38 52
	Quamannu B., Pt. de Muta	13 52	38 56
	Os Ilheos, rks., large one	14 47	39 0
	St. George, town, fort	14 49 4	39 1
	Porto Seguro, ⊡, r, Cathedral	16 26·8	39 0
	Abrolhos Is., [1½m.], ⚓ W 8m., St. Barbara, lt. Rev. 189f.	17 58	38 41
	Sta. Cruz, Ch.	16 17·3	39 0·2
	Rio Doce, W pt., entr.	19 37	39 46
	Espiritu Santo B., w′, r, b, Sta. Luzia, lt. F 66f.	20 19	40 16
	Guarapari, Ch.	20 43·9	40 27
	Calvada Islet, 4m. out, ‖₀ W	20 44	40 21
	C. St. Thomé, l, (bks. 15m. off), lt. Fl. 157f.	22 2	41 0
	St. Ann Is., 3, 2 4m., w, b, sum. grt.	22 25	41 41

Region	(166) Places	Lat. S	Lon. W
E. Coast	Anchoras Is., [1 l.]. E one	22° 40′·5	41° 45′
	C. Frio, (I. 4 2½m., ⚓ 4). S pt., lt. Fl. 300f.	23 1·3	41 57
	C. Negro, l, δ₀ 3m., pt.	22 57	42 39
	Maricas Is., 4 1 l., δ₀, Sst.	23 1	42 54
	Raza I., [¾m.]. lt. R 315f.	23 3·7	43 8 7
	RIO JANEIRO, ⊞, fort Villagagnon, [b] lt. F 59f.	22 54·8	43 9·5
	Rio Janeiro, OBSERVATORY	22 54·4	43 10·2
	Gabia Mt.	22 59	43 17
	Pt. Guaratiba, hill	23 3·6	43 32
	Marambaya I., EW 8 l., T S, W pt., (E entr. of Ilha Grande B., w, b), hill 2066f.	23 4·4	43 59
	Lage rk., 18f.	23 6·6	43 49 7
	I. Grande, EW 6 l., ⊞ N, E. pt., or Pt. Castelhanos	23 9·7	44 5·2
	Uhatuba Ch.	23 25·9	45 3·7
	Pt. Cairoçu, E sum. of mt.	23 18·2	44 35
	Porcos Is., [rks. 4m.], ⚓′, S hill	23 32 9	45 3·2
	Busios Is., [2m.], SE one	23 44·5	44 59
Brazil	St. Sebastian, (⊞, w, r, b), town	23 47	45 21
	St. Sebastian I., 2 5 l., vis. 15 l., S pt.	23 57	45 15
	Mont de Trigo, h, ⚓	23 51	45 45
	Moela, lt. F 334f.	24 2	46 13
	Santos Harb., ⊞, r, w′ 7m. up river, b, Arsenal	23 55 8	46 19
	Pt. Taypu	24 1	46 24
	Alcatrasses Is., rks., δ 5m., sum.	24 6	45 40
	Lage de Santos, rk. 7f.	24 18	46 11
	Queimada, Is., 2, 4 10m., large or outer one	24 28	46 40
	Iguape R.	24 37	47 22
	Bom Abrigo, I., [1½m.], h, ⚓, lt. Fl. 504f. (⚓ E, Cananea, ⊞, bar 3)	25 7	47 52
	Mt. Cardoz ⦶	24 59	48 6
	Figueira I., [⅓m.?], 160f., ✳₀. T	25 22	48 3
S.E. Coast	Paranagua B., ⊞, town	25 31	48 28
	I. do Mel, 6 3m., lt. F 262f.	25 33	48 18
	Coral I., [1m.?], 64f., δ₀ 2m.	25 47	48 22
	R. Guaratuba, pt., hill	25 33	48 36
	St. Francisco I., 2 6 l., h, ⚓, C. Joao Diaz, lt. F 309f.	26 10	48 33
	Tamboretes Is., [1 l.], ⚓, S one	26 21	48 32
	Itapacoroya Pt., N part	26 47	48 47
	Pt. Bombas	27 8	48 29
	Arvoredo I., 2 2m., ⚓, lt. F, Fl. 292f.	27 18	48 22
	Anhatomirim, w N 2m., r, b, fort, fl. st., lt. F 125f. ⊕	27 25·5	48 34·5
	St. Catherine I., 2 10 l., (⊞, NW-d.), N pt.	27 22·5	48 25·7
	— Nostra Senhora de Desterro	27 35 4	48 32
	Pt. dos Naufragados, lt. Rev. 149f.	27 49	48 32
	Pt. Pinheira	27 54	48 35
	Batuba Pt., lt. F 69f.	28 10	48 40
	Lagoa, (City 1m. W-d.) bar	28 28·5	48 48
	C. Sta. Marta	28 39	48 50
	Rio Grande do Sul, entr. 2, w̄, r′, E pt. tower, lt. F, Fl. 104f.	32 7	52 7

MARITIME POSITIONS

(167)	Places	Lat. S	Lon. W
R. Plate	**URUGUAY.**		
	C. Polonio, lt. F 137f.	34°25′	53°47′
	Ranger rk., small. ββ₀	34 30	53 51
	C. St. Mary, (⚓ N-d. 10), lt. Rev. 132f.	34 40	54 9
	I. Lobos, [1m.]. (rfs. E d. 3m.)	35 1	54 52
	Maldonado, tower, w ⊕	34 53·5	54 57 7
	Flores I., [1m.], lt. R² 106f.	34 57	55 55
	Monte Video, Rat I.	34 53·5	56 14
	Colonia, lt. Rev. 110f.	34 28	57 51·7
Buenos Ayres	**ARGENTINA.**		
	Buenos Ayres, Custom House, lt. F	34 36·5	58 22·2
	Santiago, pier head, lt. F	34 48	57 53·5
	C. St. Antonio, N pt., or Pt. Rasa	36 19	56 45
	Pt. Medano, (shl. 6m.), S sum.	36 59	56 41
	Mar Chiquito, (entr. impract.)	37 47	57 22
	C. Corrientes, h, ⊥, 120f., E sum.	38 5	57 29
	Pt. Mogotes, h, ⌊, 104f., δ 2m.	38 5·7	57 31·2
	Guegueu R., ‖₀	38 36	58 40
	Sierra Ventana, 3500f.	38 11·7	61 56 5
	Bahia Blanca, Mt. Hermoso, lt. F 168f.	38 59	61 39
	— Fort Argentino	38 43 8	62 15
	R. Colorados, bar 7f.	39 52	62 4
	Union B., 17f., Indian Hd, 45f., ⊥. ∗. w′, b	39 57·5	62 7·2
	San Blas Harb., ⊞, w′, b‴, r, r. Main Pt 35f., W entr.	40 30·4	62 8
	R. Negro, bar 6f.? South Barranca, r, b, lt. F 143f.	41 3	62 48
	Port St. Antonio, ⊞. w̄, b. E hd., or Villariño Pt., (bk. 4m. S), hum 40f.	40 49	64 54
	Sierra de Sn. Antonio, 1700f.	41 41	65 12
	Port San Josef, w₀, b, W head, pt.	42 14	64 25
	Valdez Penins., Pt. Norte, δ 1m.	42 3	63 48
	Pt. Delgada, 200f., SE cliff	42 46	63 37
	Nuevo G., E, or Nuevo Hd., ⊥, 200f., T, (w′, b)	42 53	64 8
	— W Hd., Nintas Pt. 240f., rks. 2m., E cliff	42 58	64 20
Patagonia, E. Coast	Salaberria rf., 3m., N and E pt.	44 25	65 8
	Port St. Elena, w‚, b‚, S Head	44 32	65 22
	C. Two Bays	44 55	65 31
	Arcé I., [1m.], SE sum.	45 1	65 29
	The Oven, or Prince Regent haven, ⊞, entr.	45 0	65 40
	Medrano rks.	45 10	65 53
	Tova I., 4m., (Cove ⊥′, b″, w)	45 6	65 56
	C. Aristazabal, (rks. off)	45 13	66 30
	Salamanca Pk., 700f.	45 34	67 20
	C. Three Pts., ab. 2000f., δ₀ 1m., NE pitch	47 6	65 51
	C. Blanco, l, rugged, (shls. 2 l.), NE sum., (S Cove, w₀, b‴)	47 12	65 44
	Port Desire, w′, b′, ruins	47 45	65 55·5
	Sea Bear B., ⚓′, b₀, ẇ at pt., Penguin I.	47 55	65 42
	Sirius rk.	48 7	65 37
	Monte Video, ab. 300f.	48 14	66 26

(168)	Places	Lat. S	Lon. W
	Watchman C., l, (shl. 2 l., 8)	48°21′	66°20′
	Bellaco rk., or Eddystone, 6f.	48 29	66 12
	C. Curioso, l, striped	49 11	67 37
	Wood's Mt., vis. 11 l.	49 13·7	67 45
	Port St. Julian, ⊞, Shell Pt.	49 15 3	67 41·2
	C. Francisco de Paulo, ⊥	49 42	67 37
	Port Sta. Cruz, bar 14f., Mt. Entrance, on S side, ⊥, 350f.	50 9	68 22
	Coy Inlet	50 54	69 8
	C. Fairweather, ab. 300f.	51 32·1	68 55·5
	Port Gallegos, ⊞, Obsn. mound	51 33·3	68 59·2
	Cape Virgins	52 20·2	68 21·7
Falkland Is.	**FALKLAND ISLANDS.**		
	Jason Is., 9 l., δ ‖, W Cay	50 58·5	61 27·7
	Grand Jason, 4m., 1210f.	51 3·2	61 3
	White rk.	51 17	60 52
	New I., NS 5m., ⊞, NW pt.	51 42	61 17
	Bird I., EW 1¼m., 410f.	52 11	60 54
	West Falkland, 25 l., Port Stephens, ⊞, entr. E pt.	52 11	60 41·2
	C. Meredith, S extr. 290f.	52 15·2	60 38
	Albemarle rk. 150f.	52 13	60 21·7
	Port Edgar, ⊞, S head, sum.	52 0·7	60 13·2
	C. Tamar, 150f., N cliff, sum.	51 17	59 29
	Port Egmont, Cove, ruins	51 21	60 3
	Wreck I., EW 3m., W extr.	51 10	60 14
	Port San Carlos, ⊞, w, b, Fanning Hd., SW sum.	51 27·2	59 7·2
	Eddystone rk., 200f.	51 10	59 25
	East Falkland, 27 l., Port Salvador, ⊞, Shag I., entr.	51 23·7	58 19
	C. Carysfort, NE cliff	51 25·2	57 50·5
	Port Louis ⊞, Settlem., fl. st. ⊕	51 32	58 7
	E extr., C. Pembroke, lt. F 110f.	51 40·7	57 42
	Port William, Stanley ⊞, w′, r, r̄, b, Gov. Store ho.	51 41·2	57 51
	Lively I., NS 7m., SE pt., (rks.)	52 4·7	58 25
	Sea Lion Is. and rf., EW 11m., W extr.	52 25	59 8·5
	George I., 7m., rks. W 2m., SW pt.	52 22·3	59 47·7
	Beauchene I., [1½m.], 200f., (rk. 5m.?), S pt.	52 55·7	59 12·7
	SOUTH ATLANTIC ISLANDS.		
	South Georgia, 30 l., C. North, pt., or C. Buller	53 59	37 28
	Wallis I., EW 4m., W pt.	54 4	38 14
	Annenkov I., [2m.], pk.	54 37	37 3
	Green I.	55 2	36 2
	Moltke Harbour, Obsn. spot	54 30·9	36 5·7
	Clerks' rks., 2 l., ⌐, S extr.	55 4	34 38
	Shag rks. ○	53 48	42 45
Sandwich Is.	Marquis de Traverse Is., h, N one, Zavodovski, [3m.]	56 18	27 29
	— W one, or Lieskov, [2m.]	56 41	28 10
	Candlemas Is., EW 6m., h, volc., E one	57 10	26 45
	Saunders' I., 6m., sum.	57 52	26 24
	Montague I., [3 l.], Cape	58 27	26 44
	Bristol I., [3 l.], E pt.	59 0	26 18
	Southern Thule Is., [3 l.], E pt	59 26	27 13
	E extreme of group, rk.	60 49	41 20

MARITIME POSITIONS

(169)	Places	Lat. S	Lon.
			West
New Orkneys	Laurie I., EW 7 l., E pt., C. Dundas, 559f.	60° 54′	44° 20′
	Murry Is, 1410f. S one	61 2	44 30
	Saddle I., [4m.], W pk., 1643f.	60 43	45 10
	Coronation I., 6/5 12 l., E sum. 5397f.	60 46	45 53
	— NW pt., or Pt. Penguin	60 33	46 40
	Despair rk.	60 36	47 12
	Inaccessible Is., [4m.], 337f.	60 40	47 38
New S. Shetland	Cornwallis I., [2m.]	61 4	54 28
	Elephant I., 6/5 9 l., E sum.	61 6	54 45
	— Rocks, NW-d., outer	61 0	55 40
	O'Brien I., [1m.]	61 32	55 52
	Rocks ○	61 43	56 50
	Bridgeman I., [2m.], 600f. volcano ○	62 10	56 40
	King George I., 6/5 13 l., E pt., or C. Melville ○	62 2	57 30
	Ridley I., [2m.]	61 48	58 0
	Livingston I., 6/5 10 l., NW pt., C. Shirreff	62 28	60 28
	Deception I., NS 10m., Port Foster, ⊞, Mt. Pond ⊕	62 55 6	60 30
	Smith I., EW 7 l., Mt. Foster, 6600f.	63 2	62 47
	William rk.	63 17	63 0
	C. Possession	63 45	61 50
	Astrolabe I., EW 4m., mid.	63 16	58 20
	Joinville I., EW 15 l., S pt., or C. Purvis	63 39	55 48
	C. Seymour	64 13	56 32
	Mt. Haddington	64 12	58 2
	Biscoe Is., Pitt I., mid.	65 20	65 38
	— Adelaide I., *h*, mid.	67 15	68 15
	Alexander I., N pt.	68 51	73 10
	St. Peter I.	68 57	90 46
	ANTARCTIC OCEAN.		East
Antarctic Ocean	Sir Jas. C. Ross' furthest	78 4	161 0
	Mt. Erebus, 12,400f.	77 33	166 58
	Mt. Sabine	71 42	169 55
	Balleny Is.	66 44	163 11
	Adelie Land, Geology Pt.	66 35	140 10
	TIERRA DEL FUEGO.		West
	Pt. Catherine, *l*	52 33	68 46
	C. St. Sebastian, ⊥, 190f., N sum.	53 19	68 10
	C. Peñas, SE cliff	53 51·5	67 33
	C. San Diego, *l*, ⊥, E pt.	54 41	65 7
Tierra del Fuego	Staten I., C. St. John	54 42·3	63 43·5
	— Vancouver, C. Kendall	54 49·8	64 6
	— C. St. Bartholomew	54 54	66 46
	Good Success B., ⚓′, w, b, S hd.	54 49	65 13
	C. Good Success *h*, ⊥, rks. close	54 55	65 22
	Ushuwia, Beagle Channel, Mission Station	54 49·4	68 18·5
	New I., 4/4 8m., δ_0. Pt. Waller	55 11	66 33
	Barneveldt Is., [2½m.], cent.	55 49	66 48·5
	C. Horn, ab. 1391f.	55 59	67 16
	Hermit I., EW 14m., West C.	55 50	67 55
	— St. Martin Cove, ⊞, b, w	55 51	67 34
	Orange B., ⊞, Pyramid I.	55 31·4	68 5·5
	False C. Horn	55 43	68 3
	Ildefonso Is., 4/4 5m., 100f., mid.	55 50	69 18

(170)	Places	Lat. S	Lon. W
Tierra del Fuego	Diego Ramirez Is., NS 5m., 587f.	56° 31′	68° 43′ [illegible]
	York Minster	55 25	70 3
	C. Castlereagh, (Stewart Hr. NE-d)	54 56·5	71 29
	Townshend Harb., ⚓‴, islet, N	54 42·3	71 55·7
	Tower rks., 2, [1½m.], S & Est.	54 37	73 3
	C. Noir, (δ 2m.), 600f., S pt.	54 30	73 6
	C. Gloucester, W pt.	54 5	73 30
	C. Inman, (rk. ⊥ 2m.)	53 19	74 19·5
	Dislocation Harb., ⊞, (w ...)	52 54	74 37
	C. Deseado, *h*, (rky. I 2m. off)	52 44	74 45
	C. Pillar, N cliff	52 43	74 42
	SOUTH AMERICA.		
	West Coast.		
	CHILE.		
Magellan Strait	C. Virgins	52 20·2	68 21·7
	Dungeness Pt.	52 24	68 25·7
	C. Possession, Refuge Beacon	52 18·3	68 56·7
	Direction Hill Beacon, 224f.	52 22	69 30
	Sandy Point, Boat-ho. lt. F 26f.	53 9·9	70 54
	Port Famine, tent N side Bay	53 38·2	70 56·5
	C. Froward, (S extr. of America)	53 54·6	71 18·5
	Port Gallant, Cross Id.	53 42	71 59·7
	Mt. Sarmiento, 7330f., 2 pks.	54 28	70 52·5
	Mt. Buckland, ab. 4000f.	54 26	70 23·7
	Port Angosto, Hoy Pt.	53 13·5	73 22·5
	Tuesday B., Cascade Pt.	52 50·2	74 29·5
	Port Churruca, Diaz I., 60f.	53 1·4	73 56
	Port Tamar, Mouatt Id.	52 56·5	73 46·5
Patagonian Inner Channels	Sholl B., Obs. spot	52 44·5	73 53
	Otter B., Obs. Pt.	52 22·5	73 40
	Fortune B., Low I.	52 15·8	73 41
	Isthmus B., Obs. Pt.	52 9·6	73 36·5
	Columbine Cove, islet	51 53·3	73 41·5
	Mayne Harb., head of Str.	51 18·5	74 4
	Puerto Bueno, Obs. Rock	50 59·4	74 11·7
	Port Grappler, Obs. Pt.	49 25·3	74 17·5
	Eden Harb., cove, (staff)	49 7·5	74 25·2
	Halt B., Obs. I.	48 54·3	74 21
	Island Harb., Obs. I.	48 3·6	74 36·2
	Guaianeco Is., S. Pedro I., 410f.	47 44	74 52·5
W. Coast Patagonia	Westminster Hall, [1m.], 1120f.	52 38	74 22
	Evangelists, Sug. loaf, 360f.	52 24	75 4
	C. Victory, or Narborough pt.	52 16	74 55
	Diana Pk.	52 8	74 48·5
	C. Isabel, *h*, ⊥, (pk. 2m. E), pt.	51 50	75 11
	Cambridge I., C. St. Lucia	51 30	75 22
	Scout rks., 10f.	50 49	75 40
	Madre de Dios Archip., W cliff, ⊥	50 36	75 32
	C. Three Pts., Rugged Hd., 2000f., (rks. 2m.)	50 1·4	75 23
	Port Henry, ⊞′, w, b, W head	50 0	75 20·5
	Mt. Corso I., SW sum., (shls. 5m.), 1420f.	49 46·4	75 32·5
	C. Montague, extr. of rocky spit	49 11·5	75 50

MARITIME POSITIONS

Coast of Chile

(171) Places	Lat. S	Lon. W
Parallel Pk., 2m. inland, 2800f.	48°46′	75°31′
Dundee rk., 45f.	48 5·5	75 37·5
Port Sta. Barbara, ⊞, W head	48 2	75 25
Guaianeco Is., Byron I., W pt.	47 46	75 20
C. Machado, ⚓,, (rks. 2m.)○	47 26·5	74 29
Purcell I., [2m.], ⚓, SW rk.○	46 55	74 39
Port Otway, ⊞, S entr., sum.	46 49·5	75 10
C. Tres Montes, ⊥, 1306f., pt.	46 59	75 26
C. Raper, rk. close	46 49	75 37·5
C. Gallegos, T	46 35	75 35
San Estevan, port, w, δ_o, entr.	46 18	75 9
Hellyer rks., [1m.]	46 4	75 11·5
C. Taytao, 2850f., ⊥, δ 1m., W pt.	45 53	75 5·5
Huamblin I., 700f., NS 3 l., ⚓, W hd.	44 49	75 12
Ypun, or Narborough I., 2½ 9m., (Scotchwell Harb., SE, b, w), S, or John Pt.	44 40·7	74 45·7
Port Low, ⊞, w″, b, r̄, Huacanec I., 2½ 2m., S pt.	43 48·5	73 59·5
Huafo I., 6/5 13m., ⌣, ⚓, NW pt., 800f., (rks. 3m.).	43 36	74 46
Chiloe I., NS 32 l., W pt., C. Quilan, ⚓	43 17	74 23
— Corona Hd., lt. F, Fl. 224f.	41 47	73 52
— C. Matalqui	42 11	74 11
Huechucucuy Hd.	41 46	74 0
Corcobado Volc., 7500f.	43 11·3	72 45·7
Chayapiren Volc., 8000f., sum.	42 48	72 31·5
C. Quedal, T	41 3	73 57·7
Pt. Galera, W pt., lt. F, Fl. 180f.	40 2	73 43·7
Gonzales Hd., N pitch	39 51	73 26·7
Fort Corral	39 52·9	73 26
Valdivia, ⊞, Niebla bluff, lt. F 121f.	39 52	73 24
Mocha I., 2½ 7m., (rks. 3m., ⚓, ‡ and ¼, ⌊,, r₀, b, w‴), sum., 1250f.	38 23	73 55·7
Tucapel Hd., (R. Leübu, E-d.)	37 36	73 38·7
Lota Point, lt. R 180f.	37 5	73 11
Sta. Maria I., NS 6m., *l*, δ, (rks. ‡ 1 l., w′, b, r), lt. Fl. 258f.	36 59	73 32
Arauco, fort	37 15	73 19
Paps of Bio Bio, 800f., SW sum.	36 48	73 11·7
Concepcion, ⊞, City, mid. at river	36 49·5	73 2·2
Talcahuano, w. r. b,, Quiriquina I., lt. R 213f.	36 36	73 3
Pt. Carranza, rks.	35 37	72 38·7
Riv. Maule, Church rk., (bar ‡ 1½m.), δ	35 19·7	72 26·2
Bucalemo Hd., (Rapel shl., ‡ 2m.)	33 52	71 49·7
Algarroba Pt.	33 26	71 42·7
Caraumilla Pt., rk	33 6	71 44·7
Bell of Quillota, 6200f., 7 l. inland	32 57·2	71 6·2
Aconcagua, 23,080f., 25 l. inland	32 38·5	69 57·7
Valparaiso, ⊞, [b], Exchange Cupola	33 2·1	71 38·5
Fort St. Antonio, site of	33 1·9	71 38·5

Chile

(172) Places	Lat. S	Lon. W
Horcon B., (⚓′, w′, r̄, b), Hd., (rks. 1½m.)	32°42′5	71°30′7
Papado B., Gobernador Mt.	32 31	71 28·7
Pichidanque B., ⚓ 8, Locos I.	32 7·9	71 32·7
Mt. Talinay, 2300f.	30 51	71 38·7
Pt. Lengua de Vaca, (B. E-d. ⚓)	30 14	71 38·7
Herradura de Coquimbo, ⊞, w_o, b_o, SW corner	29 58·7	71 22·7
Coquimbo, [b], w,, b̄, r, (⌊ Signal-hill), Tortuga Pt., lt. F, Fl. 98f.	29 57	71 21
Pajaros Islets, 2, 2½ 3m., N & W one	29 33	71 35
Chaneral I., [2m.]	29 1	71 37
Huasco Port, ⚓,, w‴, pier lt.	28 25	71 16
Herradura Pt., ⚓, ⌊′, w_o	28 6	71 13
Copiapo, ⚓,, ⌊,, w_o, r_o, b_o, land pl.	27 19·5	70 59
Morro Pt.	27 7	70 59
Port Caldera, W hd., lt. F, Fl. 121f.	27 3	70 53
Flamenco, port, S head	26 34	70 45
Ballena Pt., rks.	25 49	70 48
Grande Pt., *h*, ⌣ E, W sum. 1572f.	25 7	70 31
Paposo vill., w, b, White Hd.	25 2	70 30
Jara Hd., ⊥, w N	23 53	70 33
Antofagasta, Custom ho., lt. F 30f.	23 39	70 25
Mt. Moreno, (Jorge, old), 4160f., ⚓₀	23 28·5	70 35·2
— Constitution R I., [⚓′], w_o b_o	23 26·7	70 37·5
Leading bluff, islet off	23 1	70 32
Mt. Mexillones, 2560f., (3m. inland)	23 65	70 32
Cobija B., ẘ′, r, fl. st., ⌊	22 34	70 18
— Pk., 3330f.	22 32	70 15
C. St. Francisco, or Paquiqui	21 50	70 12
Arena Pt., *l*, ⚓ 10	21 39	70 10
R. Loa, ‖₀, w,,, and Gulley	21 28	70 3
Chipana B., ⚓′, tail of pt., ⌊⌊₀	21 23·0	70 8
Lobo, or Blanco Pt., *h*, ⊥,	21 5	70 13
Carrasco Mt., 552 f.	20 58·5	70 7
Grueso Pt., *l*, ⊥, ⌊,	20 23	70 13
Iquique, ẘ, Id., lt. F, Fl. 98f.	20 12·5	70 11·5
Pichalo Pt., projecting	19 37	70 16
Pisagna, Gulley and R., ‖₀ w,	19 34	70 14
C. Lobos	18 45	70 24
Arica, w‴, r, Iron Church (Inglesia Matrix)	18 28·7	70 20

PERU.

Peru

Places	Lat. S	Lon. W
Mount Sahama, 22,350f.	18 0	68 48
Morro of Sama, 3890f.	17 59	70 53
Coles Pt., *l*, sandy, (shls. ½m.)	17 42	71 23
Ylo, ẘ, b̄, rivul. mo.	17 37	71 21
Pt. Mexico, *l*, ⚓	17 11	71 49
Islay, port of Arequipa, Custom ho.	17 0	72 7·2
Arequipa	16 29	71 32
Mount Misti, 20,320f.	16 20	71 22
Cornejo Pt.	16 52	72 10
Quilca, ⌊,, b,, Cove, W hd.	16 42·3	72 28
Mt. Camana, (Mt. like a fort)	16 37	72 42
Pescadores Pt., ⚓₀, (rk S 1m.)	16 24	73 18
Pt. Lomas, ⚓′ ‡, w,,, r₀, fl. st.	15 33·2	74 52

MARITIME POSITIONS

	(173) Places	Lat. S	Lon. W
	Mount Illimani, 21,200f.	16°38′	67°49′
	Mount Sorata, 21,520f..........	15 50	68 30
	Port San Juan, ⚓, w_o, b_o, P_o...	15 20·9	75 23
	Beware Pt., *h*, ⊥	15 9	75 23
	Pt. Nasca, ⊥, 1020f.	14 57	75 32
	Mesa (Table) de Doña Mar'a..	14 41	75 51
	Infiernillo rk., 50f., δ_o	14 40	75 54·7
	Mt. Quemado, 2070f., ⚓	14 20	76 7·7
	Vieja I., 4/4 3½m., ⚓ NE, ⌊′ E, N pt.	14 15	76 13·7
	Carretas Hd., S pt...............	14 11	76 16·7
	Saogallan I., 2/12 2⅓m., *h*, ⊥. N sum.........................	13 50	76 28 7
	Pisco, (⌊′, w′, S 2m. of Paracca vill.). r. b′, pier lt. F	13 45	76 10
	Chincha Is., 12 3m., N pt. ...	13 38	76 24·7
	Cerro Azul ⌊⌊, *h*, ⊥	13 3	76 30·7
	Asia rk., [⅓], rks., pk., ⌊′ E	12 48	76 38·7
	Chilca Pt., ⊥, sum. 300f.	12 31	76 50
	— Port, ⚓′, ⊡, rock...........	12 29 3	76 49·5
	Pachacamac Is., 4/4 1 l., 400f.. δ_o W-d., N one	12 18	76 55·7
	Morro Solar (Bay, ⚓ δ), 860f..	12 11	77 3·7
	CALLAO, San Lorenzo I., 4/4 4½m., 1284f., C. SR. LORENZO, lt. F 980f.	12 4	77 15·7
	— ⚓, ⊡b. r, w, b′, Arsenal, fl. st.	12 4·0	77 10·5
	LIMA CATHEDRAL, SOUTH TOWER	12 3·1	77 0
	Hormigas rks., [1½m.], 25f., T, S one.....................	11 58	77 46
	Pescador Is., T, δ_o, large......	11 47	77 16
Peru	Salinas Hill, (Haura Is. SW-d.)	11 15	77 36
	Pelado rk., small	11 28	77 49
	Huacho B., ⚓′5, ⌊′, r. w, b, pt.	11 9	77 37
	Supé B., ⚓′, r, ẇ, vill., W pt..	10 49·7	77 44
	Darwin Pk., 5800f..............	10 30	77 46
	Guaimey B., ⚓′, ww_o, r, b′ ...	10 6	78 9
	Legarto Hd., ⊥	10 7	78 10
	Culebras Pt., ⚓ N..............	9 58	78 12
	Mt. Mongon, *h*, W sum. 3900f.	9 38	78 18
	Casma B., ⌊′, w, r, b............	9 28	78 22
	Samanco B., ⌊′, w̄′, r, b′, huts..	9 15·6	78 29
	Mt. Division, 3 pks., 1880f. ...	9 11	78 34
	Ferrol B., w_o, N pt.	9 7	78 36
	Santa I., [1½m.], ⚓′ NE, ⌊′ w, r	9 2	78 39
	Santa B., ⚓ 5, wat. pl.	9 0	78 38
	Chao Is., large, [⅓m.], 120f...	8 46	78 45
	Guañape Hill, ab. 700f., (Is. 2/+ 8m.)	8 27	78 53
	Huanchaco Road, ⌊o, r, ẇ, Ch.	8 5	79 5
	Truxillo, (1½m. inland), w_o, r, Ch.	8 7 5	79 0
	Pacasmayo Pt., ⚓, ⌊′, w, r, b, mole lt. F 65f.................	7 24	79 33
	Mt. Sulivan, 5000f., 17m. inland	7 17	79 17·7
	Eten Hill, 640f., mole lt. F 65f.	6 56 5	79 52
	Lambayeque Rd., δ ⚓, ⌊o, w_o, r, b_o .... ○	6 46	79 56 7
	Lobos de Afuera Is., NS 3m., ab. 100f., ✱o, w_o, b_o, δ_o, Chichal de Afuera	6 54	80 41·2
	Lobos de Tierra, NS 2 l., ⚓ ✝4, S pt...	6 28 3	80 50·2
	Aguja Pt., ⊥, 150f.	5 55	81 6
	Piura R., ⚓′, Sechura Church	5 35	80 46·7
	Saddle of Payta, 1300f.........	5 12	81 5·2

	(174) Places	Lat.	Lon. W
		South	
	PAYTA, CATHEDRAL TOWER ...	5° 5′	81° 7′2
	Pariña Pt., ⊥, 80f.	4 41	81 19
	C. Blanco, *h*. ⊥, δ_o	4 18	81 14
	Malpelo Pt., *l*, ✱	3 31	80 28·2
	ECUADOR.		
	Sta. Clara I., [1½m.], shls., lt. F. Fl. 256f..................	3 11	80 24·5
	Puná I., 4/4 9 l., Pt. Española, Consulate, lt. F 131f.......	2 47·5	79 54
	Guayaquil, ẇ, r. b, Arsenal ...	2 12·4	79 51·4
	Mount Chimborazo, 20,498f....	1 30	78 47
Ecuador	St. Elena Pt., lt. F, Fl. 470f....	2 11	80 59
	Salango I., [1m.] w. ‖o E.......	1 36	80 52
	Plata I., 4/4 3m., 790f., lt. F...	1 17	81 3
	C. St. Lorenzo	1 3	80 55
	Manta, lt. F 88f.	0 56·8	80 42·7
	Mount Cotopaxi, 19,613f.......	0 43	78 18
	Quito, 9,343f.....................	0 14	78 22
	C. Passado	0 21·5	80 29·7
		North	
	Galera Pt.	0 50	80 5
	Atacames, town, w, (shls.) ...	0 53	79 53
	Esmeralda R., Coquito Pt., lt. F	1 0	79 41·5
	Pt. Mangles......................	1 35	79 5
	Tumaco Rd., Morro Chico ..	1 49·6	78 44·5
	COLOMBIA.		
	Pt. Guascama........	2 37	78 24
	I. Gorgona, 2/+2 5m., 1296f., N pt.	3 0 0	78 10
	Pt. Chirambirà	4 17	77 29
	C. Corrientes	5 29	77 32
	C. Francisco de Solano.........	6 17	77 27
	Pt. Caracoles	7 40	78 16
	Pt. Guarachina, (S side, entr. G. St. Michael)	8 6	78 21·7
	I. Rey, 2/12 5 l., Pt. Cocos	8 13	78 54
	I. St. Jose, [2 l.], S pt..........	8 12	79 7
Panama Bay	PANAMA, ⚓, NE bast.	8 57·2	79 32
	Taboga I., [2m.], vill. ✝4, w...	8 47·3	79 32 2
	Otoque Is., 2/12 2½m., pk..........	8 35·0	79 35
	Pt. Chame	8 39	79 41
	Pt. Mala	7 28	79 58
	Point Puercos.....................	7 14	80 26
	CENTRAL AMERICA.		
	Hicaron I., (Quicara), (and islet S), NS 5m., S islet	7 12	81 47 7
	Quibo I., 2/12 7 l., Adelarda Pt.	7 31	81 53
Costa Rica	Montuosa I., [½m.]	7 28	82 15
	Bahia Honda, ⚓, w, Sentinela I., at entr., (w ✝5 2m)	7 43·5	81 32
	Magnetic Is., (off Port Nuevo, ⚓), [4c.] ...... ⊕	8 5	81 49
	Pt. Burica. Id. off	8 2·3	82 53·5
	Vinda rock	8 6	82 10
	Ladrones Is.	7 52	82 26
	G. of Dulce, C. Matapalo, (rks. off)	8 23	83 17
	Caño I., [1m.], 404f., (w‴ ✝4 1½m.)	8 43	83 53·2
Nicaragua	Nicoya G., Puntas Arenas Harb., ⚓, w, r, Pan de Azucar........................	9 55·8	84 52
	C. Blanco, ⦣, ✱, (islet S, 1½m., ‖), 193f............ ...	9 32	85 7
	Guinonos Point, (reef off) ...	9 54	85 41

MARITIME POSITIONS

Region	(175) Places	Lat N	Lon. W
Nicaragua	C. Velas	10°21·5	85°53′
	Culebra, ⚓, entr. S, Vira-d res Is.	10 35	85 43·2
	St. Elena Pt.	10 53·5	85 58
	Salinas B., Salinas Is., [3c.]	11 2·8	85 43·5
	Port St. Juan, S bluff, lt. F 490f.	11 15·2	85 53·5
San Salvador	C. Desolado	11 59	86 42
	Realejo, ⚓, r, b, Cardon I., ¾m., N pt., (w 1m.), lt F 64f.	12 27·9	87 12·7
	Volcan Viejo, 5670f.	12 41	87 1·5
	Pt. Conseguina, (Volcano, 2830f., 3 l.)	12 58·5	87 35
	G. of Conchagua, or Fonseca, Port de la Union, ⚓, w′, r, Chicarene Pt.	13 17·1	87 47
	S. Miguel, vol., 7134f.	13 25·5	88 18
	LIBERTAD, r, PIER HD. lt. F	13 28·8	89 19·2
	Pt. Remedios, l, (rf. 3m.)	13 30	89 48
	Acajutla, vill., ⚓′ lt. F.	13 34·4	89 50·7
Guatemala	San Jose de Guatemala, Custom ho., lt. F	13 55·3	90 49·7
	Acatenango Volcano, 12,890f.	14 29	90 53·5
	Mount Tacana, 14,000f.	15 8·5	92 7
	NORTH AMERICA.		
	MEXICO. West Coast.		
Mexico, W. Coast	Tonala Bar	15 59	93 58
	St. Franc. de Tehuantepec, bar	16 13	94 45
	Salina Cruz, Morro, 244f.	16 9·8	95 12·5
	Port Guatulco, rky. islets	15 44·4	96 8·2
	Galera Point	15 57·6	97 41·5
	Acapulco, ⚓, w′, r, Fort St. Diego. b ⊕	16 50·8	99 55·7
	Pt. Tequepa	17 16	101 4·5
	Morro Petatlan, 640f.	17 31·5	101 27
	Port Sihuatenejo, NW bight	17 38·0	101 3·3
	Istapa, or Isla Grande B.	17 40·3	101 40
	Mangrove bluff, 35f.	17 55·5	102 12
	Tejupan Papa, 5660f.	18 24	103 11
	Colima Volcano, 12,000f.	19 25	103 33
	Manzanilla B., ⚓′, w, village	19 3·2	104 19·7
	Port Navidad, S head, 705f.	19 11	104 43
	Pt. Farallones, (rks. off)	19 23·5	105 3
	C. Corrientes, flat, 506f.	20 24	105 42·5
	Corventa rk., 25f.	20 45	105 51
	Tres Marias Is., S Juanito, 150f.	21 43	106 41
	Mt. St. Juan, 7550f., 5 l. inland	21 26	104 58·5
	San Blas, w, r, r̄, Arsenal	21 32·5	105 19
	Isabel I., w, b, pk. 280f.	21 52	105 53·5
	Chiametla R., W ent. pt.	22 47·5	106 2
	Mazatlan, w, Cust. ho.	23 11·7	106 27·2
Gulf of California	Culiacan R., Altata Railway Station	24 37·7	107 56
	I. St. Ignacio, [1m.], 465f.	25 26	109 24·2
	Esterro de Ajiabampo, bar	26 16·3	109 17·2
	Pt. Rosa	26 40	109 40·7
	Lobos I., [5 l.], 75f., SW pt.	27 21	110 38
	Guaymas, ⚓, w′ w, fort	27 55·4	110 55
	C. Haro, lt. F. Fl. 346f.	27 50·5	110 54·7
	Tetas de Cabra, 1633f.	28 1	111 5
	I. St. Pedro Nalasco, 1071f.	27 58	111 24
	Tiburon I., [9 l.], Willard Pt., 315f.	28 51	112 36
	C. Tepoca	30 16	112 52

Region	(176) Places	Lat. N	Lon. W
Gulf of California	Rocky Bluff, 408f.	31°20′	113°40′
	Colorado R., Port Isabel beacon	31 46	114 42
	San Felipe Pt., 940f.	31 2	114 49·5
	Guardia I., 13 l., Pt. Refugio	29 33·1	113 35·2
	Sta. Teresa B., N pt.	28 25	112 51
	I. Tortuga, [2m.], 1016f.	27 26	111 53
	Sta. Inez Pt.	27 3	111 56
	Mulege, ⚓	26 53·5	111 57·5
	Ildefonso I., [1m.], 387f.	26 37	111 26
	La Giganta Pk., 5794f.	26 6	111 35
	Loreto	26 0·5	111 20·5
	Carmen I., 1572f., 4 l., Salinas B.	25 59·5	111 7
	Catalina I., [7m.], 1548f., pt.	25 42	110 47
	Sta. Cruz I., [3m.], pk., 1500f	25 16	110 43
	San José I., 6 l., 2077f., Amortajada B., N pt.	24 54·5	110 38·7
	Espiritu Santo I., 4 l., Lupona Pt.	24 24·2	110 20·5
	La Paz	24 10	110 20
	Cerralbo I., 5 l., 2477f., Montana rock	24 8	109 47
	Pt. Arenas	24 4	109 49
	San José, Mission, r, w''''	23 3·5	109 41·7
	C. St. Lucas, rks., h, (w, vill.), 251f.	22 53	109 53
Lower California	Magdalena B., ⚓, Custom ho. lt.	24 38·3	112 8·7
	C. St. Lazaro, Mt. 1300f.	24 47	112 17·5
	San Juanico Pt.	26 2	112 17·5
	Pt. Abreojos	26 42	113 33
	I. Asuncion, 100f.	27 6	114 17·7
	Port St. Bartholomew, N hd.	27 39·8	114 52
	I. Cerros, 3955f., NS 8 l., Morro Redondo	28 1·3	115 11
	Is. San Benito, W one, 650f.	28 18	115 36
	Playa Maria B.	28 55	114 32
	I. San Geronimo, [1 l.], 172f. ⊕	29 48	115 47·7
	St. Quintin, ⚓, Sextant Pt.	30 22	115 59
	C. Colnett, SW pt., 400f.	30 57	116 19·5
	Todos Santos Bay, Enseñeda Pt., 370f.	31 51	117 37·2
	Coronados rks., 5m., S isl., 674f.	32 23·9	117 14
	UNITED STATES.		
	California.		
Upper California	Boundary Obelisk	32 32	117 7·5
	St. Diego, ⚓, ẇ, Pt. Loma, lt. Fl. 462f.	32 40·2	117 14·7
	St. Juan B., ⚓, outer rk.	33 26·9	117 46
	St. Pedro B., ⚓, ẇ, r, lt. Fl. 156f.	33 43·2	118 17
	Cortez Bank, 2½	32 26	119 6
	St. Clemente I., [6 l.], SE ⚓	32 49	118 25·2
	Sta. Catalina I., [6 l.], Raper B., Barracks	33 26	118 29·7
	St. Nicolas I., 6m., John Begg rk., [2c.], NW-d.	33 21·7	119 41·7
	Sta Barbara I., [2m.]	33 28·5	119 2·2
	Sta. Cruz I., [7 l.], Anacapa B., Observ. Pt.	34 1·6	119 32
	Sta. Rosa I., [3 l.], Becher B. Observ. Pt.	34 1	120 2·7
	San Miguel I., Cuyler Hr., Prince I	34 3·3	120 20

MARITIME POSITIONS

Region	(177) Places	Lat. N	Lon. W
Upper California	St. Barbara, lt. F 180f.	34°23'.7	120°43'.2
	Pt. Conception, lt. R. 135f. ...	34 26.8	120 28
	Pt. Arguilla	34 35	120 39
	San Luis Obispo, Whaler I ...	35 9.5	120 45
	Pt. Pinos, T, lt. F 91f.........	36 37.9	121 56
	Monterey. w, w₂, r, b, fort	36 36.4	121 53
	Pt. Ano Nuevo	37 6.7	122 20
	Farallones rks., [1m.], pk., lt Fl. 360f.	37 41.8	123 0
	Sr. FRANCISCO, FORT PT., lt. F 124f., S side, entr.	37 48.5	122 28.7
	Mt. Bolbones, 3765f., 10 l. inl.	37 52.9	121 54.5
	Pt. de los Reyes, lt. Fl. 296f...	37 59.6	123 1.2
	C. Bodega, (Russ. Stor, w) ...	38 17.7	123 4.5
	Pt. Arena. lt. F 156f..........	38 57.5	123 44.2
	C. Mendocino, lt. Fl. 423f. ...	40 26.3	124 24.5
Oregon	Humboldt B., lt. F 53f........	40 46	124 13.2
	Crescent City, Pt. St. George, lt. Fl. 80f.	41 44.6	124 12
	C. Orford, lt. F 256f.	42 50.1	124 33.7
	C. Gregory, Empire City, lt F, Fl. 75f.	43 20.6	124 23.2
	C. Perpetua.......................	44 18	124 6.7
	Yaquina Hd., lt. F 61f.........	44 40.6	124 4.7
	C. Look-out	45 20	124 0.7
	Columbia R., Fort Astoria ...	46 11	123 50
	— C. Disappointment, lt. F 232f.	46 16.5	124 3.2
Washington	Shoalwater B., Toke Pt., lt F. Fl. 85f.	46 43	124 4.5
	Gray's Harb., ⊠, bar, Pt. Brown	46 56.2	124 8
	Pt. Grenville	47 18.3	124 16.5
	Destruction I., rf. W 2½m......	47 40.5	124 28.5
	Flattery rks.	48 10.3	124 46
	C. Flattery, Tatouch I., lt. F 162f....	48 23.2	124 44.7
	Neeah B., Wyadda I., SW pt.	48 22.5	124 36.2
	New Dungeness Pt., lt. F 100f.	48 11	123 6
	Port Discovery	48 5.5	122 54.5
	Whidbey I., Admiralty Hd., lt. F 119f.	48 9.4	122 39.5
	Admiralty Inlet, Foulweather Bluff	47 56.3	122 37.2
	— Seattle Town..................	47 36	122 21
	— Hood Canal, Union City ...	47 21	123 7
	Puget Sound, Nisqually	47 7	122 40
	— Olympia Town	47 3	122 55
	Smith, or Blunt I., lt. Fl. 90f.	48 19	122 51.5
	Mount Baker, 10,694f.	48 49	121 46
	Semiahmoo Bay.................	49 0	122 45.5
	BRITISH COLUMBIA.		
Strait of Georgia	Roberts Pt., W side	49 0	123 5.5
	Fraser River, lt. F 52f.	49 3.7	123 17.0
	— Garry Pt.	49 7.1	123 12.0
	— New Westm., Milit. Barr...	49 13	122 54.5
	Burrard Inlet, Atkinson Pt., lt Rev. 119f	49 20	123 16
	— City of Vancouver, Canadian and Pacific Railway Wharf......................	49 17	123 6
	Bowen I., Roger Curtis C......	49 20.3	123 26.2
	Howe Sound, Plumper Cove...	49 24.6	123 29.2
	Texada I., Pt. Upwood........	49 29.7	124 8.7

Region	(178) Places	Lat. N	Lon. W
Queen Charlotte Sound	Texada, Marshall Pt............	49°48'.0	124°40'
	Jervis Inlet, Hardy I., SW end	49 43.7	124 14.7
	Mystery Rock	49 54.8	124 46
	Hernando I., S pt.	49 58	124 56.2
	Mittlenatch I., 200f.	49 57	125 1.5
	Valdez I., C. Mudge...........	50 0.7	125 10.4
	Thurlow I., Knox B.	50 24.2	125 39
	Port Neville, Robber's Nob....	50 31.1	126 4.3
	Port Harvey. tide pole islet .	50 34	126 16.7
	Wells pass, Tracey Hb., Starrk	50 51	126 53.2
	Blunden Harb., Byrnes I.......	50 54.4	127 19
	Slingsby Chan., Dalkeith Pt...	51 4.7	127 40
	C. Caution	51 9.6	127 48
Vancouver I., N.E. Coast	Port San Juan, pinnacle rk., N side of Bay..............	48 33.5	124 27.5
	Sooke Inlet, Secretary I.	48 19.6	123 42.7
	Race I., lt. Fl. 118f.	48 17.7	123 32.2
	ESQUIMALT H., ⊞, w, r, [b], DUNTZE HEAD	48 25.8	123 26.7
	Victoria Harb., Laurel Pt. ..	48 25.4	123 23
	Nanaimo Hb., Dr. Benson's ho.	49 10.2	123 56.6
	Nanoose Harb., entrance rk....	49 15.7	124 8
	Baynes Sd., Henry B., Beak Pt.	49 36.5	124 51.2
	Seymour Narrows, Plumper B., W pt....................	50 10.0	125 22.5
	Albert B., Cormorant I., bluff	50 35.0	126 57.5
	Beaver Harb., shell islet	50 42.6	127 25
	P. Alexander, Goletas Chn., islet in centre of the port	50 50.8	127 40
	Bull Hb., Hope I., N pt. Ind. Is.	50 54.8	127 56
Vancouver I., S.W. Coast	C. Scott, 500f., sum. of cape...	50 46.7	128 26.7
	Triangle I., 680f., Scott Is., W pt.	50 51.9	129 6.5
	C. Russell, δ	50 41	128 23.5
	C. Palmerston, δ.................	50 36.5	128 19
	Quatsino Sd., ent., mt. 1275f., δ	50 27.5	128 3.7
	— Observatory rk., N harb. ...	50 29.4	128 3.7
	— Observ. I.. Koprino Harb...	50 30	127 52.2
	— Kitten I., Hecate Cove ...	50 32.4	127 36.2
	— Reef Pt.........................	50 21.3	128 0
	Clerke reefs, W extreme	50 12.3	127 55
	C. Cook, or Woody Pt., Solander I...................	50 6.5	127 57.2
	Nasparti Inlet, Head beach...	50 11.3	127 38
	Sulivan reefs	50 4.5	127 41
	Lookout I., δ, W extreme......	50 0.0	127 26.5
	Ninety-eight-feet Island.........	49 47.7	127 21.7
	Kyuquot Sound, Shingle Pt., ent. of Narrowgut Creek.	49 59.9	127 9.5
	Thirty-feet Island	49 55.2	127 16
	Totchu Pt., δ.....................	49 51.2	127 9.5
	Esperanza Inlet, Obser. rk., Queen's Cove	49 52.7	127 0
	Nuchatlitz In., Port Langford, Colwood I............	49 47.3	126 57
	Ferrer Pt.	49 44.7	126 59.7
	Bajo Pt., rf. 3m.................	49 37.5	126 50.7
	Nootka Sound, Friendly Cove	49 35.5	126 37.5
	Estevan Pt., S extr., rf. 2m. ...	40 22.1	126 32.5
	Hesquiat Harb., Boat Cove, leading Mt. 2726f.........	49 27.5	126 25.5
	Refuge Cove, vil. on W side...	49 20.8	126 16.7
	Flores I., summit 3000f.	49 18.2	126 9
	Sea Otter rk.. 6f.	49 11.5	126 8.5
	Clayoquot Sound, Obs. I., Hecate B.	49 15.4	125 56.2

MARITIME POSITIONS

	(179) Places	Lat. N	Lon. W
	Gowlland rks., 10 to 15f.	49° 3.6	125° 51.7
	Barclay Sound, Obs. I., Alberni Can., Stamp Harb.	49 13.8	124 50.0
	— Observ. I., Island Harb....	48 54.7	125 17
	— Danger rk....................	48 49.2	125 18.5
	— Cape Beale, lt. Fl. 161f. ...	48 47.4	125 13
Hecate Strait	Virgin rks., 50f.	51 17	128 13
	Pearl rks., 15f.	51 22	128 2
	Dalkeith Pt. ....⊕	51 4.7	127 40
	Safety Cove ....⊕	51 31.7	127 56.5
	Goldstream Harb. ....⊕	51 43.3	128 0.5
	Namu Harb.	51 51.7	127 52.5
	Loughlin Harb.	52 8.6	128 10.2
	Kynumpt Harb..................	51 12.3	128 11.5
	C. Swaine ....○	52 18	128 32
	Carter Bay	52 49.7	128 24.5
	Holmes Bay	53 16.4	129 5.2
	Stewart Anchorage	53 52.5	130 5.2
	Alpha Bay	53 52	130 17.5
	C. Ibbetson......................○	54 1	130 36
	Duncan Bay, Observatory Pt....	54 20.2	130 27.5
	P. Simpson Fort..................	54 33.5	130 26.2
Queen Charlotte Is.	Queen Charlotte's Is., 4/4 55 l., S pt C. St. James, (rks. -¼ 1000f.)......... ○	51 55	131 2
	— C. Henry ....○	52 55.5	132 21
	— Skidegate I., Anchor Cov. ⊕	53 12.5	132 14.2
	— Hippa I., [1 l.], village...○	53 33	132 58
	— Frederick I. ....○	53 59	133 9
	— Pt. North ....○	54 15	132 56
	UNITED STATES. **Alaska.**		
Sitka Archipelago	Port Stewart, ⊞, S st islet......	55 38.3	131 47
	C. Chacon	54 41	132 1
	C. Muzon	54 40	132 41
	Forrester's I., NS 4m., S pt. (rks.)	54 48	133 35
	C. Addington....................	55 27	133 52
	Port Protection, ⊞, Pt. Baker	56 20.5	133 39
	Coronation Is., [3 l.], S pt....	55 50	134 12
	Hazy Is.	55 54	134 32
	C. Ommanney	56 10	134 37
	Sitka, ⊞, Arsenal, lt. F	57 2.9	135 19.7
	C. Edgecumbe, 2855f.	57 0	135 49
	C. Cross, rks.	57 56	136 31
	C. Spencer, rks.	58 13	136 35
	C. Fairweather	58 51	137 50
	Mt. Fairweather, 15,500f.......	58 58	137 27
	Port Mulgrave, ⊞, Pt. Turner	59 33.0	139 43.0
	Pt. Manby	59 45	140 17
Alaska	Mt. St. Elias, 19,500f.	60 20	140 58
	C. Suckling........................	60 1	144 15
	Kayes I., 2/2 5 l., S pt., C. Hamond.............. ⊖	59 52	144 50
	Port Etches, ⊞, Phipps Pt....	60 21.2	146 50.2
	Montague I., S pt. C. Clear......	59 46	148 0
	C. Puget..........................	59 56	148 30
	Pt. Gore	59 11	150 52
	C. Elizabeth, E pt.	59 9	151 42
	Anchor Pt., S hd.	59 49	151 47
	Iliamna Pk., 12,066f., vol.......	60 3	153 0
	Pt. Campbell	61 4	150 9
	Mt. St. Augustine, (Id. [3 l.]), sum..........................	59 22	153 30

	(180) Places	Lat. N	Lon.
			West
Alaska	C. Douglas, E pt.	58° 54′	153° 17′
	Barren Is., [5 l.], *h*, E pt......	58 58	151 50
	Pt Banks	58 38	152 12
	Kadiak I., 2/2 27 l., E pt., C. Greville, or Tolstoy, rks.	57 37	152 0
	— St. Paul Harb....	57 47.5	152 19.7
	— Trinity Is., SW pt.	56 23	154 40
	Chirikoff I., [3 l.], N pt.	55 56	155 34
	Shumagin Is., Nagai I., Sanborn Harb.	55 8.1	159 58.2
	Sannakh I., sum. 1850f.........	54 25.3	162 44
Aleutian Islands	Unimak Pass, Ugamok I., S. pt	54 12	164 57
	Unalashka, 4/4 23 l., Iliuliuk Port, ⊞, church ⊕	53 50.2	166 30.7
	Bogosloff I., [2 m.], ‖∘ pk, 344f.	53 57.5	167 58
	Umnak I., Vsevidoff, vol 8000f	53 15	168 20
	Yunaska I., 4/4 5 l., sum. 2864f	52 36	170 47
	Amukhta I., [2 l.], 3738f. ...	52 28	171 17
	Seguam I., 4/4 5m., 2098f. SW pt..........................	52 17.5	172 36
	Amlia I., EW 12 l., ‡∘ (rk -¼ 5m.) Suchikoff B.......	52 2.2	173 22.5
	Atka I., 4/4 20 l., vol., 4988f., Nazan B. ...... ⊕	52 10.6	174 15
	Sitchin I., [2 l.], *h*, vol., 5083f.	52 5	176 8
	Kanaga I., 2/2 9 l., N pt.	51 56	177 5
	Tanaga I., EW 11 l., (w in Bay, *W d.*), NW pk. 7108f.	51 53	178 9
	Gareloi, or Burning I., or Volcano, [2 l.], 5334f. ...	51 47.5	178 52.5
	Amatignak I., 1921f., West pt.	51 18	179 12
			East
	I. of Seven Mountains, Semisopochnoi, 3122f. [3 l.]	51 56	179 37.5
	Amchitka I., 6/6 11 l., Constantine Harbour ...... ⊕	51 23.6	179 10.2
	Kyska I., NS 8 l., Kyska Harbour	51 59.1	177 29.2
	Bouldyr I., [1 l.], (rks. E 6 l.), mid. 1145f.	52 34	175 45
	Agattu, [4 l.], sum. ......○	52 25	173 10
	Semichi, 2 Is., 6/6 2 l., Alaid I., 818f	52 45	173 52
	Attu, EW 15 l., 3084f., W pt., C. Wrangel	52 58	172 27
	— Chichogoff Harb............	52 55.7	173 11.5
			West
Behring Sea, Coast of Alaska	Pribeloff Is., St. Paul I., EW 8 l., NE pt., (rf. E 2 l.)...	57 15.2	170 7
	— St. George I., 6/6 4 l., E pt.	56 36.7	169 27.5
	I. Amak, [1 l.], rk. *NW-d*....	55 27	163 3
	Port Moller, ⊞, tongue, S pt.	55 56	160 35
	C. Strogonov, (I. off)............	56 52	158 42
	Bristol B., C. Constantine, (bks. *S-d.* 4 l.)	58 25	158 44
	— Nagnek R., Suworoff vill....	58 40	157 3
	Hagenmeister I., 2/2 6 l., S pt.	58 34	160 50
	C. Newenham....................	58 41	162 5
	C. Avinoff, Anogogmute	59 39	163 45
	Nunivak I., EW 23 l., N pt., C. Etolin....................	60 27	166 5
	I. St. Mathew, 4/4 10 l., 1500f., SE pt., C. Upright.........	60 18	172 4
	— Hall I., 1500f., [2 l.], N pt.	60 32	172 40

MARITIME POSITIONS

(181)	Places		Lat. N	Lon. W
Behring's Strait	I. St. Lawreoce, 6/5 30 l., N E pt.		63°15′	168°38′
	— West pt., C. Sanachno		63 26	171 50
	C. Romantzof, 70f.		61 52	166 10
	Mouth of Yukon R.		62 20	164 20
	I. Stuart, [3 l.]		63 23	162 37
	St. Michael, fort		63 26	161 24
	C. Darby		64 17	162 45
	Sledge I., [2m.], Aziak		64 30	166 8
	Pt. Rodney		64 39	166 18
	King I, [1 l.]. N pt., 700f.		65 0	168 1
	Port Clarence, ⊞, w, Pt. Spencer	⊕	65 16·7	166 48

(182)	Places		Lat. N	Lon. W
Arctic Ocean	C. Prince of Wales (extreme W pt of America)		65°33′	167°59′
	Fairway rock		65 39	168 43
	Diomede Is, 2, N one, or Ratmanoff I., [5m.], S pt.		65 47	169 4
	Kotzebue Sound, C. Espenberg, E pt.		66 33	163 28
	— Chamisso I., 231f., w E summit	⊕	66 13·2	161 46
	C Krusentern, *l*, sandy		67 11	163 37
	Pt. Hope, *l*		68 20	166 45
	C. Lisburne, 849f.		68 52	166 6
	Icy Cape (shoals)		70 20	161 46
	Pt. Barrow, Noowook	⊕	71 23	156 22

TABLE 11.

PLACES AT WHICH DOCKS, WET OR DRY, OR SLIPS, MAY BE FOUND, REPAIRS MADE, COALS OBTAINED, &c.

London
Chatham
Sheerness
Deal
Dover
Shoreham ?
Portsmouth
Southampton
Topsham
Dartmouth
Devonport
Falmouth
Penzance
Bristol
Newport
Cardiff
Swansea
Hartlepool
Pembroke
Holyhead
Liverpool
Barrow
Whitehaven
Greenock
Glasgow
Stornoway
Lerwick ?
Inverness ?
Aberdeen
Grangemouth
Dundee
Leith
Berwick
Tynemouth
Sunderland
Hull
Great Grimsby
King's Lynn
Ipswich

Cork
Limerick
Sligo
Londonderry
Belfast
Larne
Drogheda
Dublin
Kingstown
Dundalk
Carrickfergus
Wexford

Ostend
Antwerp
Rotterdam
Flushing
Harlingen
Ghent
Delfzyl
Amsterdam

William-haven
Hamburg

Elsineur
Copenhagen
Kiel
Stettin
Dantzig
Memel
Riga
Oscarshamn
Kronstadt
Stockholm
Carlscrona
Malmo
Gottenburg

Christiansund
Christiania
Christiansand
Bergen
Trondheim
Archangel

Dunkerque
Calais
Dieppe
Havre
Trouville
Honfleur
Caen
Cherbourg
St. Pierre
St. Helier's
Granville
Morlaix ?
Brest
L'Orient
St. Nazaire
Port de Palais ?
Nantes
Rochelle
Rochefort
Bordeaux
Lormont
Bayonne

Bilbao
Rivadeo
Ferrol
Corunna
Vigo

Figueira
Oporto
Lisbon

Huelva
Cadiz
Gibraltar
Malaga
Cartagena
Valencia

Barcelona

Marseille
Port Ciotat
Toulon

Port Mahon
Cagliari
Caprera I.

Genoa
Spezia
Leghorn
Civita Vecchia
Naples
Messina
Catania
Syracuse
Marsala
Palermo
Taranto
Bari
Ancona
Venice

Trieste
Pola
Fiume

Corfu
Patras
Salamis
Piræus
Syra

Constantinople
Rostoff
Odessa
Nicolaieff
Sevastopol
Batoum

Smyrna
Suda Bay
Beirut
Alexandria
Port Said
Suez

Malta
Tunis
Algiers

Palmas
Teneriffe
Flores
St. Michael's
St. Vincent
Bermuda

Senegal
Goree
Bathurst
Sierra Leone
Quetta

Dix Cove
Elmira
C. Coast ?
Whydah
Princes I.
Lagos
Fernando Po
Congo
Loaodo
Ascension ?
St. Helena
Cape Town
Simon's B.

Port Elizabeth
East London
Natal
Comoro Is. ?
Mozambique
Reunion
Mauritius
Mahé
Zanzibar
Aden

Muscat
Basrah
Karachi
Bombay
Colombo
Trincomalee
Negapatam
Pondicherri
Madras
Calcutta
Chittagong
Akyab
Rangoon
Moulmein
Mergui
Port Blair

Acheen
Penang
Malacca
Singapore
Padang
Bangkok
Saigon

Canton
Whampoa
Hong Kong
Swatau
Amoy
Fu-chau
Shanghae
Tamsui
Ningpo
Taku
New-chang
Vladivostock

Nagasaki
Hiogo
Kobe
Osaka
Yedo
Hakodadi

Labuan
Manilla
Macassar
Batavia
Samarang
Sourabaya
Amboina
Ternate

Swan R.
King G.'s Sound
Adelaide
Port Phillip
Port Western
Hobart
Port Jackson
Newcastle
Brisbane
Maryborough
Townsville

Nelson
Wellington
Auckland
Otago
Lyttelton
Napier
Wangaroa

Noumea
Levuka
Tahiti
Honolulu

St. John's
Montreal
Toronto
Quebec
Picton
Sydney
Halifax
Gamden
St. John's, New Brk.

Portland
Bath
Portsmouth
Boston
New London
New York
Philadelphia
Baltimore
Norfolk
Charleston

Savannah
Pensacola
Mobile
New Orleans

Nassau
Havana
Santiago de Cuba
Cienfuegos
Port Royal
Port au Prince
Porto Rico
St. Thomas
Sta. Cruz
Antigua
Martinique
St. Lucia ?
Barbados
Grenada

Vera Cruz
Belize
Porto Bello
Curaçao
Caraccas
Port Spain
Demerara
Campeche
Surinam
Cayenne ?

Parà ?
Maranham ?
Pernambuco
Bahia
Rio Janeiro
Rio Grande de Sul
Monte Video
Buenos Ayres

Port Stanley, Falkland Is. ?

Coronel
Talcuhuano
Valparaiso
Coquimbo
Caldera
Antofagasta

Iquique
Callao
Payta
Guayaquil
Panama

Acapulco
Mazatlan
Guaymas
St. Francisco
Portland
Esquimault

THE NAVIGABLE MERCATORIAL DISTANCES IN NAUTICAL MILES BETWEEN EUROPE AND THE PRINCIPAL PORTS OF NORTH AMERICA AND THE WEST INDIES.

PORTS	LIVERPOOL																														
Plymouth	344	Plymouth																													
Queenstown	235	212	Queenstown																												
GIBRALTAR	1280	1050	1090	GIBRALTAR																											
Halifax	2485	2442	2257	2710	Halifax																										
New York	3022	2981	2830	3256	580	New York																									
Bermuda	2982	2920	2754	2968	751	690	Bermuda																								
St. Thomas	3596	3506	3368	3336	1587	1432	840	St. Thomas and Lisbon 3161																							
S. Juan, Po. Rico	3658	3568	3430	3416	1582	1400	829	81	San Juan, Porto Rico																						
Port au Prince	3864	3914	3756	3848	1685	1362	991	621	540	Port au Prince																					
Jamaica	4099	4037	3871	3963	1810	1484	1135	703	633	280	Jamaica and Lisbon 3772																				
Havana	4132	4070	3904	4237	1650	1187	1150	1044	963	650	743	Havana and Lisbon 3979																			
Vera Cruz	4937	4875	4709	5044	2425	1994	1946	1890	1809	1883	1200	807	Vera Cruz and Lisbon 4786																		
New Orleans	4051	4589	4423	4817	2148	1717	1069	1600	1519	1938	1105	590	800	New Orleans and Lisbon 4532																	
Antigua	3538	3438	3310	3218	1653	1547	932	181	262	802	882	1225	2018	1781	Antigua and Lisbon 3056																
Guadeloupe	3541	3441	3313	3215	1723	1617	1002	256	322	877	900	1550	2076	2011	70	Guadeloupe															
Dominica	3581	3481	3353	3237	1743	1637	1022	271	337	922	911	1582	2050	1985	120	47	Dominica and Lisbon 3100														
Martinique	3623	3523	3395	3240	1823	1717	1102	317	381	958	952	1608	2090	2031	170	100	55	Martinique & Bordeaux 3640													
St. Vincent	3698	3508	3483	3205	1890	1783	1169	370	432	975	970	1628	2106	2041	245	194	133	93	St. Vincent												
Barbados	3660	3538	3423	3245	1910	1820	1185	433	499	1065	1055	1723	2201	2136	285	220	170	133	97	Barbados and Lisbon 3099											
Grenada	3776	3673	3558	3386	1954	1847	1232	419	473	980	960	1632	2100	2025	307	250	200	157	74	150	Grenada and Lisbon 3249										
Trinidad	3837	3734	3619	3434	2055	1943	1333	511	569	1042	1008	1700	2168	2113	402	359	312	258	173	206	90	Trinidad									
Curaçao	4063	3963	3835	3720	1987	1763	1237	461	488	645	572	1249	1847	1872	525	510	488	491	460	556	425	456	Curaçao and Lisbon 3588								
La Guayra	4019	3919	3791	3701	2064	1818	1318	480	508	798	725	1402	2000	2025	488	460	438	419	368	456	315	318	153	La Guayra							
Savanilla	4319	4229	4091	4060	2200	1783	1447	723	754	585	431	1046	1485	1428	840	840	823	835	815	912	795	831	370	513	Savanilla and Lisbon 3896						
Cartagena	4381	4291	4153	4122	2262	1832	1509	785	816	634	468	1002	1501	1444	902	902	885	897	877	974	857	893	432	575	62	Cartagena and Lisbon 3958					
Colon	4616	4526	4388	4263	2294	1980	1630	1020	970	768	547	979	1404	1369	1145	1150	1133	1145	1125	1222	1105	1141	680	823	310	263	Colon and Lisbon 4201				
Greytown	4761	4699	4533	4523	2360	2046	1679	1187	1112	839	577	841	1260	1232	1330	1337	1325	1337	1320	1417	1300	1336	875	1018	517	481	245	Greytown			
Belize	4680	4618	4451	4558	2139	1708	1708	1363	1278	915	648	521	858	827	1533	1557	1551	1578	1581	1678	1563	1597	1153	1306	867	857	731	583	Belize and Lisbon 4390		
Demerara	3877	3779	3679	3397	2285	2206	1570	793	854	1346	1306	1998	2466	2401	656	586	563	493	423	390	380	341	782	653	1154	1216	1464	659	1943	Demerara and Lisbon 3287	
PERNAMBUCO	4094	3860	3874	3140	3545	3681	2992	2422	2467	3079	3008	3137	4205	4102	2247	2182	2157	2105	2082	2002	2072	2037	2493	2355	2868	2930	3178	3373	3634	1701	PERNAMBUCO

Liverpool to Holyhead 70
" to Longships 273
Plymouth to Lizard 47
" to Gravesend 294

Bermuda Narrows to Dockyard 11 m.
Port Royal to Kingston 6 m.

NORTH AMERICAN AND WEST INDIAN PORTS.

PORTS	St. Thomas	Havana	New Orleans	Vera Cruz	San Juan, Pto. Rico	Port au Prince	Jamaica	Colon	Barbados	Demerara
Quebec	2340	2320	2854	3120	2245	2374	2505	2997	2547	2932
Boston	1500	1410	1944	2219	1485	1524	1655	2147	1807	2252
Philadelphia	1422	1144	1678	1944	1394	1333	1464	1958	1831	2216
Baltimore	1406	1105	1639	1905	1370	1290	1421	1913	1826	2211
Washington	1416	1115	1649	1915	1380	1300	1431	1923	1836	2221
Charleston	1187	646	1180	1446	1135	953	1084	1576	1620	1980

BRITISH TO N. AMERICAN PORTS: NORTHERN ROUTE

PORTS	Belle Isle	Quebec	Cape Race	Halifax	Boston	New York	Phila-d'phia	Baltimore	Washingt'n
Glasgow	1821	2561	1908	2368	2725	2918	3073	3240	3243
Belfast	1775	2515	1862	2322	2679	2872	3027	3194	3197
Liverp'l	1691	2631	1977	2437	2794	2987	3142	3309	3312
Inistrh'l	1689	2429	1775	2235	2592	2785	2940	3107	3110
C. Wrath	1800	2540	1843	2275	2632	2825	2980	3147	3150

	LONDON																							
Liverpool	650	Liverpool																						
Plymouth	317	346	Plymouth																					
Queenstown	552	241	211	Queenstown																				
Belle Isle	2268	1953	1951	1763	Belle Isle																			
Quebec	3008	2693	2691	2501	740	Quebec																		
Pr. Edward I.	2711	2452	2394	2224	509	559	Pr. Edward I.																	
St. John's	2248	1986	1931	1758	299	869	503	St. John's																
Cape Race	2208	2009	1951	1781	359	809	443	60	Cape Race															
Halifax	2759	2469	2442	2257	600	748	260	530	460	Halifax														
Sable Island	2623	2356	2306	2128	528	705	217	377	317	170	Sable Island													
Boston	3133	2807	2816	2629	968	1117	629	867	817	379	510	Boston												
New York	3298	3022	2981	2830	1086	1318	830	1070	1010	580	684	336	New York											
Philadelphia	3508	3232	3191	3004	1155	1458	975	1225	1165	725	836	493	234	Philadelphia										
Baltimore	3680	3404	3363	3176	1470	1608	1120	1392	1332	886	1007	665	405	358	Baltimore									
Washington	3683	3407	3366	3179	1473	1611	1123	1395	1335	889	1010	663	410	364	182	Washington								
Charleston	3850	3575	3533	3347	1642	1783	1295	1572	1512	1052	1175	832	603	573	532	537	Charleston							
Bermuda	3237	2932	2920	2754	1207	1427	939	1095	1035	700	753	707	690	722	767	772	771	Bermuda						
Nassau	4053	3792	3736	3564	1942	2081	1593	1801	1741	1351	1432	1150	966	914	877	881	501	787	Nassau					
Gibraltar	1330	1287	1050	1090	2352	3221	2733	2245	2240	2710	2540	3084	3256	3357	3555	3558	3701	2968	3777	Gibraltar				
PERNAMBUCO	4130	4094	3860	3874	3511	4100	3735	3512	3452	3541	3397	3662	3681	3732	3738	3741	3602	2592	3228	3140	PERNAMBUCO			
CAPE OF G. HOPE	6156	6113	5882	5906	6490	6931	6565	6282	6222	6530	6385	6792	6817	6872	6967	6970	6861	6160	6589	5119	3346	CAPE OF G. HOPE		
Lisbon	1035	1000	764	810	1955	2803	2437	1977	1994	2463	2301	2825	3020	3173	3325	3330	3462	2745	3565	300	3158	5152	Lisbon	
Bordeaux	689	673	420	535	2219	3024	2658	2183	2215	2708	2556	3080	3279	3452	3623	3628	3784	3121	3954	1008	3822	5838	732	Bordeaux

90 m. taken from London Distances give Distances to Dover (*see* p. 643A).

New York to Sandy Hook	..	15
Philadelphia to C. Henlopen		87
Baltimore to C. Henry	..	155
Washington to C. Henry	..	160
Quebec to Canso I. ..	..	610
Bermuda to St. Michaels	..	1900
Quebec to Montreal ..	..	135

	HALIFAX												
New York	580	New York											
Bermuda	760	690	Bermuda										
Jamaica	1810	1484	1135	Jamaica									
Barbados	1910	1820	1185	1055	Barbados								
Gibraltar	2710	3256	2968	3963	3245	Gibraltar							
Fayal	1613	2136	1809	2831	2254	1121	Fayal						
Madeira	2300	2812	2428	3377	2625	610	676	Madeira					
Tenerife	2464	2939	2511	3471	2615	717	871	259	Tenerife				
St. Vincent	2571	2955	2359	2960	2019	1565	1323	1042	843	St. Vincent, C. Verd I.			
Sierra Leone	3409	3803	3208	3781	2751	1977	2032	1579	1320	855	Sierra Leone		
Fernando Po	4845	5214	4619	5137	4096	3412	3455	3000	2741	2274	1465	Fernando Po	
Nassau	1451	966	806	670	1299	3777	2602	3208	3284	2964	3800	5192	Nassau

Fayal and Pernambuco	2812
Nassau and St. Thomas's	866
" and Havana	390
Sierra Leone and St Thomas's	3070

DISTANCES SOUTHWARD OF THE DRIFT ICE

	Quebec	Halifax	Boston	New York
Liverpool	3171	2685	2097	3152
Queenstown	2904	2424	2702	2885
Plymouth	3070	2585	2929	3053
Lisbon	2958	2402		
Bordeaux	3207	2501		

THE NAVIGABLE MERCATORIAL DISTANCES IN NAUTICAL MILES BETWEEN EUROPE AND THE PRINCIPAL PORTS ON THE SOUTH-EAST COAST OF SOUTH AMERICA.

Ports	LONDON	Liverpool	Southampton	Plymouth	Lisbon	GIBRALTAR	Madeira	Tenerife	St. Vincent	Para	Maranham	Ceara	PERNAMBUCO	Maceio	Bahia	Victoria	Cape Frio	Rio de Jan.	Santos	St. Catharina	Rio Grande	Maldonado	Monte Video	Buenos Ayres	Nuevo Gulf	Falklands	Cape Virgins	Sierra Leone	Ascension	St. Helena
Liverpool	650																													
Southampton	207	463																												
Plymouth	317	344	131																											
Lisbon	1034	1000	865	764																										
GIBRALTAR	1320	1280	1140	1050	300																									
Madeira	1465	1417	1300	1210	525	603																								
Tenerife	1690	1651	1525	1420	715	717	259																							
St. Vincent	2507	2459	2347	2250	1560	1565	1042	843																						
Para	4170	4107	4009	3890	3260	3303	2735	2586	1779																					
Maranham	4080	4017	3919	3800	3175	3199	2650	2466	1634	357																				
Ceara	3994	3931	3799	3680	3022	3197	2500	2325	1462	673	374																			
PERNAMBUCO	4130	4034	3956	3360	3158	3140	2651	2442	1609	1070	759	385																		
Maceio	4254	4191	4093	3974	3268	3250	2761	2561	1719	1169	869	495	110																	
Bahia	4520	4457	4359	4240	3534	3516	3027	2827	1985	1435	1135	701	376	265																
Victoria	4947	4884	4786	4667	3961	3943	3454	3254	2412	1862	1562	1188	803	693	448															
Cape Frio	5125	5061	4952	4851	4164	4133	3657	3432	2615	2064	1764	1390	1006	805	650	202														
Rio de Janeiro	5192	5128	5019	4918	4231	4200	3724	3499	2682	2131	1831	1457	1073	872	737	269	67													
Santos	5397	5334	5207	5117	4409	4391	3902	3702	2860	2309	2009	1635	1251	1050	895	447	245	200												
St. Catharina	5609	5546	5419	5329	4621	4603	4114	3914	3072	2521	2221	1847	1463	1262	1107	659	457	413	253											
Rio Grande	5912	5849	5722	5632	4924	4906	4417	4217	3375	2824	2524	2150	1765	1565	1410	962	760	725	579	326										
Maldonado	6143	6080	5953	5863	5155	5137	4648	4448	3606	3055	2755	2381	1997	1796	1641	1193	991	945	815	562	236									
Monte Video	6179	6115	6006	5905	5218	5187	4711	4486	3669	3118	2818	2444	2060	1859	1704	1256	1054	1020	878	625	299	63								
Buenos Ayres	6289	6225	6116	6015	5328	5297	4821	4596	3778	3228	2928	2558	2169	1969	1814	1366	1164	1130	988	735	409	173	110							
Nuevo Gulf	6802	6739	6612	6522	5814	5796	5307	5107	4265	3714	3416	3040	2656	2455	2300	1852	1670	1604	1474	1221	895	659	642	702						
Falklands	7030	6951	6842	6723	6053	6030	5546	5346	4504	3953	3653	3279	2895	2694	2539	2091	1889	1872	1749	1502	1202	1013	1002	1067	604					
Cape Virgins	7263	7204	7090	6994	6307	6280	5800	5575	4749	4198	3898	3524	3149	2939	2784	2336	2143	2106	1986	1733	1407	1210	1184	1244	602	421				
Sierra Leone	3020	2957	2830	2740	2010	1977	1579	1320	855	2215	1974	1685	1631	1713	1919	2323	2532	2599	2777	2989	3292	3523	3586	3690	4182	4298	4642			
Ascension	3903	3841	3713	3620	2893	2857	2461	2203	1620	2131	1852	1478	1233	1291	1476	1724	1823	1890	2068	2217	2545	2761	2824	2928	3377	3407	3778	1000		
St. Helena	4502	4440	4312	4225	3492	3470	3061	2802	2270	2788	2489	2115	1774	1838	1916	1971	2073	2140	2318	2491	2710	2885	2948	3052	3429	3308	3719	1550	700	
CAPE HORN	7401	7337	7223	7132	6440	6416	5933	5708	4898	4347	4047	3673	3289	3098	2933	2485	2283	2261	2175	1922	1596	1373	1300	1420	814	441	292	4732	3848	3749

	Para	Maranham	Ceara	Ascension
Barbados	1165	1370	1630	2991
Demerara	890	1130	1390	2780

AFRICAN TO AMERICAN PORTS.

	New York	Baltimore	Charleston	Jamaica	Barbados	Demerara	Cayenne	Para	Maranham	Pernambuco	Bahia	Rio	Monte Video
Sierra Leone	3803	3970	3984	3781	2751	2666	2360	2250	1980	1631	1919	2599	3586
Cape Palmas	4277	4444	4397	4146	3105	3008	2665	2490	2230	1785	2120	2660	3026
Accra	4734	4901	4854	4603	3562	3465	3122	2947	2687	2245	2565	3056	4002
Lagos	4961	5128	5081	4830	3789	3692	3349	3174	2914	2467	2780	3202	4200
Fernando Po	5268	5435	5388	5137	4006	3998	3650	3495	3212	2710	3017	3447	4348
St. Thomas	5175	5342	5295	5044	4018	3910	3400	3365	3080	2550	2840	3235	4122
River Congo	5621	5788	5758	5473	4437	4300	3925	3712	3410	2820	3080	3304	4173
Walfisch Bay	6267	6332	6362	5893	4863	4639	4263	3968	3650	2985	3083	3185	3771

	Cadiz	Tangier	St. Vincent	Lisbon	Finisterre	Bordeaux	Ushant	Liverpool	Plymouth	Gravesend
Gibraltar	75	30	190	300	550	1008	930	1280	1050	1297
Cadiz		58	136	246	496	954	872	1226	990	1238
Tangier			170	280	530	988	906	1260	1024	1272
St. Vincent				110	360	818	736	1090	854	1102
Lisbon					270	728	646	1000	764	1012
Finisterre						458	370	730	494	742
Bordeaux							300	673	420	606
Ushant								373	120	366
Liverpool									344	627
Plymouth										294
Gravesend										

Ports	HALIFAX	New York	Bermuda	New Orleans	Jamaica	Demerara	Cayenne	Cape S. Roque	PERNAMBUCO	Bahia	Rio de Jan.	Santos	Rio Grande	M. Video	Falklands	C. Virgins	Sierra Leone	Ascension	St. Helena	CAPE OF GOOD HOPE
New York	580																			
Bermuda	760	690																		
New Orleans	2148	1717	1669																	
Jamaica	1801	1484	1108	1105																
Demerara	2285	2206	1570	2401	1306															
Cayenne	2457	2459	1787	2777	1683	376														
Cape S. Roque	3379	3519	2830	3940	2846	1539	1163													
PERNAMBUCO	3541	3681	2992	4102	3008	1701	1325	162												
Bahia	3917	4057	3368	4478	3384	2077	1701	538	376											
Rio de Janeiro	4614	4754	4065	5175	4081	2774	2398	1235	1073	737										
Santos	4792	4932	4243	5353	4259	2952	2576	1413	1251	895	200									
Rio Grande	5307	5447	4758	5876	4782	3475	3099	1938	1766	1410	725	579								
Monte Video	5601	5741	5052	6162	5068	3761	3385	2222	2060	1704	1020	878	299							
Falklands	6436	6576	5887	6997	5903	4596	4220	3057	2895	2539	1872	1749	1202	1012						
Cape Virgins	6687	6827	6138	7248	6154	4847	4471	3308	3149	2784	2106	1986	1407	1184	421					
Sierra Leone	3409	3803	3208	4879	3781	2700	2352	1555	1631	1919	2599	2777	3292	3586	4298	4642				
Ascension	4137	4403	3765	5105	4010	2781	2405	1275	1233	1476	1890	2068	2525	2824	3407	3778	1000			
St. Helena	4830	5100	4462	5775	4680	3417	3041	1864	1774	1916	2140	2318	2491	2710	3308	3719	1550	700		
C. OF GOOD HOPE	6530	6817	6127	7464	6369	5024	4648	3511	3346	3361	3270	3446	3549	3600	3474	3913	3192	2420	1720	
CAPE HORN	6830	6970	6281	5536	6297	4990	4614	3451	3289	2933	2261	2175	1593	1360	441	292	4732	3848	3749	3791

	Plymouth	Cape Verde	S. Vincent	Sierra Leone	Ascension	S. Helena	Cape of G. Hope	Rio	Cape Horn	Monte Video	S. Paul's	Trinadad
S. Paul's Rocks	3230	1018	997	1071	1045	1725	3431	1598	3814	2585		
Trinadad	4424	2227	2261	1971	1153	1370	2668	779	2742	1654	1283	
Tristan d'Acunha	5347	3124	3374	2754	1754	1323	1512	1804	2507	2145	2469	1391

	San Diego	C. Virgins	Cape Frio	C. St. Thomé	Ushant	Plymouth	Liverpool
C. Horn	110	292	2281	2356	7017	7132	7337
San Diego		182	2171	2246	6907	7022	7232
C. Virgins			2143	2218	6879	6994	7204
C. Frio				80	4736	4851	5061
C. St. Thomé					4656	4771	4982
Ushant						120	373
Plymouth							344
Liverpool							

	Queenstown	Fayal
Plymouth	211	1261
Lisbon	810	929
Gibraltar	1090	1121
Madeira	1225	676
Tenerife	1457	871
St. Vincent	2260	1323
Para	3825	2615

	Queenstown	Fayal
Maranham	3875	2602
Ceara	3695	2603
Pernambuco	3870	2812
Rio	4943	3885
Monte Video	5930	4872
C. Virgins	7010	5952
C. Horn	7160	6101

Cape of Good Hope to London	6156
" " " Liverpool	6113
" " " Fayal	5170

THE NAVIGABLE MERCATORIAL DISTANCES IN NAUTICAL MILES BETWEEN EUROPE AND THE PRINCIPAL PORTS OF THE WEST COAST OF AFRICA.

Ports	London	Liverpool	Southampton	Plymouth	Lisbon	Fayal	Madeira	Tenerife	St. Vincent	Cape Verde	Bathurst	Sierra Leone	Monrovia	Cape Palmas	C. Three Points
Liverpool	65[illegible]														
Southampton	207	464													
Plymouth	317	344	131												
Lisbon	1035	1000	865	764											
Fayal	1575	1401	1380	1201	929										
Madeira	1465	1417	1300	1210	525	676									
Tenerife	1690	1651	1525	1420	715	871	259								
St. Vincent	2507	2459	2347	2250	1560	1323	1042	843							
CAPE VERDE	2514	2472	2341	2242	1520	1543	1075	850	455						
Bathurst	2664	2562	2431	2332	1610	1633	1165	920	545	90					
Sierra Leone	3000	2958	2827	2728	2006	2029	1561	1316	855	486	405				
Monrovia	3204	3162	3031	2932	2210	2233	1765	1520	1070	690	602	254			
Cape Palmas	3424	3382	3251	3152	2430	2453	1985	1740	1283	910	822	474	220		
Cape Three Points	3758	3716	3585	3486	2704	2787	2319	2074	1617	1244	1156	808	554	334	
Cape Coast Castle	3815	3773	3642	3543	2821	2844	2376	2131	1674	1301	1213	865	611	391	57
Accra	3881	3839	3708	3609	2887	2910	2442	2197	1740	1367	1279	931	677	457	123
River Volta	3938	3806	3765	3666	2944	2967	2499	2254	1797	1424	1336	988	734	514	180
Lagos	4108	4066	3935	3836	3114	3137	2069	2424	1967	1594	1506	1158	904	684	350
Cape Formosa	4247	4205	4074	3975	3253	3276	2808	2563	2106	1733	1645	1297	1043	823	489
Bonny	4317	4275	4144	4045	3323	3346	2878	2633	2176	1803	1715	1367	1110	890	559
Old Calabar	4412	4370	4239	4140	3418	3441	2973	2728	2271	1898	1810	1462	1218	988	654
Fernando Po	4415	4373	4242	4143	3421	3444	2976	2731	2274	1901	1813	1465	1221	991	657
Princes I.	4346	4304	4173	4074	3352	3375	2807	2062	2205	1832	1744	1396	1152	922	597
St. Thomas	4322	4280	4140	4050	3328	3351	2883	2638	2181	1808	1720	1372	1118	898	590
Anno Bom	4293	4251	4120	4021	3299	3322	2854	2609	2152	1779	1691	1343	1089	869	590
Ascension	3888	3846	3715	3616	2894	2899	2449	2204	1630	1374	1291	1000	875	832	1049
St. Helena	4406	4454	4323	4224	3502	3514	3057	2812	2270	1982	1890	1570	1360	1213	1247
Gaboon Point	4434	4442	4311	4212	3400	3513	3045	2800	2343	1970	1882	1534	1280	1060	740
Cape Lopez	4450	4408	4277	4178	3456	3479	3011	2766	2309	1936	1848	1500	1246	1026	722

Ports	C. Coast Castle	Accra	River Volta	Lagos	C. Formosa	Bonny River	Old Calabar	Fernando Po	Princes I.	St. Thomas	Anno Bom	Ascension	St. Helena	Gaboon Point
Accra	66													
River Volta	123	57												
Lagos	293	227	170											
Cape Formosa	440	383	333	205										
Bonny	510	453	403	275	70									
Old Calabar	605	548	498	370	165	105								
Fernando Po	613	551	501	380	168	110	80							
Princes I.	562	517	475	375	180	165	207	150						
St. Thomas	557	520	487	417	240	245	296	246	90					
Anno Bom	565	542	521	488	343	360	418	461	215	125				
Ascension	1101	1165	1215	1363	1419	1478	1573	1560	1423	1353	1251			
St. Helena	1280	1320	1348	1440	1390	1428	1505	1470	1303	1215	1094	700		
Gaboon Point	702	657	616	513	303	282	289	216	141	161	246	1499	1316	
Cape Lopez	687	648	612	527	335	315	335	271	155	132	192	1445	1248	71

Tenerife to Finistère 926

	Plymouth	Tenerife	Cape Verde	St. Vincent	Sierra Leone	Ascension	St. Helena	Cape of G. Hope	Cape Horn	Monte Video	Rio de Janeiro	S. Paul's Rocks	Trinidad
S. Paul's Rocks	3744	1820	1081	997	1078	1045	1725	3431	3814	2585	1598		
Trinidad I.	4454	3030	2227	2261	1971	1153	1370	2668	2742	1654	779	1283	
Tristan d'Acunha	5374	3960	3124	3374	2754	1754	1323	1512	2507	2145	1804	2409	1391
Queenstown	[illegible]	1457	2277	2260	2703	3641	4216	5910	7163	5934	4917	3252	4465

	London	Gravesend	Dover	Finisterre	Madeira	Tenerife	Cape Verde	Jamaica	Pernambuco	Bermuda	Antigua	St. Thomas
Ushant	389	366	299	376	1080	1302	2125	3962	3740	2848	3372	3434

	Demerara	Barbados
Ushant	3707	3466

Ports	Plymouth	Cape Verde	St. Vincent	Sierra Leone	Ascension	St. Helena	Rio de Janeiro	C. Palmas	C. Three Points	Lagos	St. Thomas	C. Lopez	Congo River	Loando	Benguela	Walfisch Bay	Table Bay	CAPE OF GOOD HOPE	Algoa Bay	Natal
Cape Verde	2242																			
St. Vincent	2250	455																		
Sierra Leone	2728	486	855																	
Ascension	3616	1374	1630	1000																
St. Helena	4225	1982	2270	1550	700															
Rio de Janeiro	4918	2740	2682	2599	1900	2150														
Cape Palmas	3152	915	1283	474	832	1213	2660													
Cape Three Points	3486	1244	1617	808	1049	1247	3040	334												
Lagos	3836	1504	1967	1158	1363	1440	3263	684	350											
St. Thomas	4050	1808	2181	1372	1353	1215	3235	898	590	417										
Cape Lopez	4178	1936	2309	1500	1445	1248	3314	1026	722	527	132									
Congo River	4496	2254	2627	1818	1588	1220	3304	1344	1080	927	507	400								
Loando	4635	2393	2766	1957	1643	1192	3353	1483	1225	1092	673	562	176							
Benguela	4764	2522	2895	2086	1655	1145	3285	1612	1384	1282	808	764	390	222						
Walfisch Bay	5223	2081	3325	2541	1897	1212	3184	2071	1901	1871	1472	1390	1040	893	700					
Table Bay	5852	3606	3938	3162	2396	1700	3270	2716	2575	2554	2150	2080	1743	1593	1400	700				
CAPE OF G. HOPE	5882	3632	3960	3192	2420	1720	3310	2746	2605	2584	2180	2210	1773	1623	1430	735	40			
Algoa Bay	6257	4007	4335	3567	2795	2095	3683	3121	2980	2959	2555	2485	2148	1998	1805	1110	415	375		
Natal	6633	4383	4711	3943	3171	2471	4059	3497	3356	3335	2931	2561	2525	2375	2181	1486	791	751	386	
Delagoa Bay	6922	4072	5000	4232	3460	2760	4348	3786	3645	1624	3220	3250	2814	2664	2470	1775	1080	1040	675	293

Ports	Queenstown	Halifax	New York	Bermuda	Jamaica	Barbados	Gibraltar	Madeira	St. Vincent	Sierra Leone	Cape Coast Castle	Fernando Po	Ascension
Halifax	2257												
New York	2800	580											
Bermuda	2754	780	690										
Jamaica	3871	1801	1484	1136									
Barbados	3423	1910	1820	1185	1055								
Gibraltar	1090	2710	3256	2968	3963	2245							
Madeira	1225	2300	2812	2428	3377	2625	610						
St. Vincent	2260	2571	2955	2359	2960	2019	1565	1042					
Sierra Leone	2763	3409	3803	3208	3781	2751	1986	1561	855				
Cape Coast Castle	3576	4245	4814	4019	4537	3496	2801	2376	1674	865			
Fernando Po	4176	4845	5214	4619	5137	4096	3401	2976	2274	1465	613		
Ascension	3641	4137	4403	3765	4010	2991	2874	2449	1630	1000	1101	1550	
Cape of Good Hope	5910	6530	6817	6160	6369	5292	5132	4707	3976	3192	2603	2459	2420

Gibraltar to C. Verde, 1500

Cape of Good Hope to	London	6156
" " "	Liverpool	6113
" " "	Cape Horn	3791
" " "	Simon's Bay	15

THE NAVIGABLE MERCATORIAL DISTANCES IN NAUTICAL MILES BETWEEN EUROPE AND THE PRINCIPAL PORTS OF THE EAST INDIES VIA THE SUEZ CANAL.

Ports	London	Liverpool	Portsmouth	Plymouth	Lisbon	Gibraltar	Malta	Brindisi	Alexandria	Port Said	Suez	Jiddah	Musawwa	Hodeida	Aden
Liverpool	650														
Portsmouth	193	463													
Plymouth	317	344	130												
Lisbon	1035	1000	865	764											
GIBRALTAR	1320	1280	1144	1050	300										
Malta	2304	2261	2128	2034	1279	984									
Brindisi	2605	2562	2429	2335	1580	1285	362								
Alexandria	3114	3071	2938	2844	2089	1794	820	830							
Port Said	3240	3197	3064	2970	2215	1920	936	940	146						
Suez	3327	3284	3151	3057	2302	2007	1023	1027	233	87					
Jiddah	3957	3914	3777	3687	2932	2630	1657	1647	863	727	640				
Musawwa	4277	4234	4097	4007	3252	2957	1977	1967	1180	1037	950	350			
Hodeida	4412	4369	4232	4142	3392	3092	2112	2102	1312	1172	1085	452	206		
ADEN	4635	4592	4455	4365	3610	3315	2335	2335	1535	1395	1308	694	403	232	
Cape Guardafui	5011	4968	4831	4741	3986	3691	2711	2701	1911	1771	1684	1070	779	608	376
Kurian Murian, I.	5335	5298	5155	5065	4310	4015	3035	3025	2235	2095	2008	1394	1103	932	700
Maskat	5835	5798	5655	5565	4810	4515	3535	3525	2735	2595	2508	1894	1603	1432	1200
Bunder Abbas	6082	6045	5902	5812	5057	4762	3782	3772	2982	2842	2755	2141	1850	1679	1447
Abu Shehr	6419	6382	6239	6149	5394	5099	4119	4109	3319	3179	3092	2478	2187	2016	1784
Basrah	6595	6558	6415	6325	5570	5275	4295	4285	3495	3355	3268	2654	2363	2192	1960
Karachi	6085	6042	5905	5815	5060	4765	3785	3785	2985	2845	2758	2144	1853	1682	1450
Bombay	6272	6289	6092	6002	5247	4952	3972	3972	3172	3032	2945	2331	2040	1869	1637
Ratnagiri	6286	6243	6106	6016	5261	4966	3986	3976	3186	3046	2959	2345	2054	1883	1651
Goa	6303	6260	6123	6033	5278	4983	4003	3993	3203	3063	2976	2362	2071	1900	1668
Mangalore	6358	6315	6178	6088	5333	5038	4058	4048	3258	3118	3031	2417	2126	1955	1723
Cochin	6514	6471	6334	6244	5489	5194	4214	4204	3414	3274	3187	2573	2282	2111	1879
Cape Comorin	6589	6546	6409	6319	5564	5269	4289	4279	3489	3349	3262	2648	2357	2186	1954
Tuticorin	6669	6627	6489	6399	5644	5349	4369	4359	3569	3429	3342	2728	2437	2266	2034
Colombo	6739	6696	6559	6469	5714	5419	4439	4429	3639	3495	3408	2798	2507	2336	2100
GALLE	6769	6726	6589	6499	5744	5449	4469	4469	3669	3529	3442	2828	2537	2366	2134

[1024 Plymouth to Tangier]

Ports	Cape Guardafui	Kurian Murian, I.	Maskat	Bunder Abbas	Abu Shehr	Basrah	Karachi	Bombay	Ratnagiri	Goa	Mangalore	Cochin	C. Comorin	Tuticorin	Colombo
Kurian Murian, I.	433														
Maskat	913	500													
Bunder Abbas	1160	747	247												
Abu Shehr	1497	1084	584	411											
Basrah	1666	1260	760	577	184										
Karachi	1180	751	468	043	952	1107									
Bombay	1303	951	850	1084	1421	1620	500								
Ratnagiri	1302	982	906	1153	1496	1646	603	120							
Goa	1312	1010	977	1224	1561	1717	676	210	94						
Mangalore	1353	1098	1110	1357	1694	1850	846	380	264	170					
Cochin	1503	1232	1289	1536	1873	2029	1039	573	457	364	197				
Cape Comorin	1578	1332	1409	1656	1993	2149	1162	706	580	486	300	126			
Tuticorin	1658	1412	1489	1736	2073	2229	1240	776	660	566	380	206	80		
Colombo	1718	1494	1571	1818	2155	2311	1324	903	742	648	482	288	162	151	
GALLE	1758	1542	1619	1866	2203	2379	1372	930	790	696	530	336	210	211	69

Colombo to Albany 3366
GALLE to Albany 3297

Ports	Madras	Calcutta	Maulmain	Singapore	Manila	Hongkong	C. Leeuwin	Adelaide	Melbourne	Hobart	Sydney	Auckland
London	7305	7950	7800	8270	9590	9710	9600	10 770	11 080	11.230	11.540	12 640
Liverpool	7256	7906	7958	8223	9546	9663	9550	10 727	11 032	11 183	11.496	12 592
Plymouth	7029	7679	7731	7996	9319	9436	9323	10.500	10 805	10 956	11,269	12 365
Queenstown	7069	7719	7771	8036	9359	9476	9363	10.540	10 845	10,996	11,309	12 405
Gibraltar	5979	6629	6681	6946	8269	8386	8273	9450	9755	9906	10.219	11.315

	Halifax	New York	Bermuda	Jamaica	Barbados	Madeira
Aden	6025	6571	6283	7278	6560	3918
Galle	8150	8705	8417	9412	8694	6052
Singapore	9656	10 209	9914	10 909	10,191	7549

	Queenstown
Gibraltar	1090
Malta	2070
Alexandria	2890
Port Said	3010
Aden	4405
Karachi	5842
Bombay	6042
Colombo	6509
Galle	6539

Ports	GALLE	Trincomalee	Pondicherry	Madras	Coringa	Gopalpur	Calcutta	Chittagong	Akyab	C. Negrais	Rangoon	Maulmain	Mergui	Penang	Port Blair	PULO BRASSE	ANJER POINT	Diego Garcia	Mahe
Trincomalee	250																		
Pondicherry	477	227																	
Madras	530	280	72																
Coringa	760	510	330	258															
Gopalpur	922	672	530	458	200														
Calcutta	1180	970	797	780	482	305													
Chittagong	1212	1018	918	850	626	500	314												
Akyab	1136	956	884	842	624	463	366	143											
C. Negrais	1017	870	870	837	700	572	560	407	264										
Rangoon	1190	1016	1047	1000	877	759	765	584	441	205									
Maulmain	1230	1057	1069	1040	919	791	800	626	483	240	130								
Mergui	1195	1051	1115	1097	1000	904	910	727	584	348	295	250							
Penang	1213	1164	1267	1280	1255	1222	1290	1137	994	730	738	722	472						
Port Blair	843	723	743	761	694	663	763	655	512	272	368	405	358	580					
PULO BRASSE	887	845	995	997	1020	1022	1125	1030	887	623	676	667	456	307	385				
ANJER POINT	1712	1722	1909	1927	2011	2062	2165	2070	1927	1663	1716	1707	1496	1347	1425	1040			
Diego Garcia	935	1134	1361	1409	1727	1882	2136	2211	2040	1903	2345	2336	1971	1872	1669	1565	2013		
Mahe	1620	1858	2085	2133	2348	2503	2761	2822	2763	2643	2786	2822	2773	2749	2447	2442	3019	1017	
Zanzibar	2583	2827	3054	3102	3317	3472	3730	3791	3732	3612	3755	3791	3748	3758	3416	3451	4027	2017	1017

	Ratnagiri	Goa	Mangalore	Cochin	Colombo
Natal	3731	3677	3612	3570	3635
Beira	3163	3121	3068	2998	3075
Mozambique	2690	2675	2630	2580	2656
Zanzibar	2470	2460	2428	2420	2555
Mahe	1676	1622	1555	1510	1596
Mauritius	2405	2340	2225	2112	2083
Delagoa	3554	3440	3373	3360	3440

EAST INDIAN AND AUSTRALIAN PORTS VIA CAPE LEEUWIN.

Ports	Aden	Bombay	Galle	Madras	Calcutta	Singapore	Hongkong	C. LEEUWIN	Adelaide	Melbourne	Hobart Town	Sydney	Auckland	Brisbane
Madras	2664	1460	530											
Calcutta	3314	2110	1180	780										
Singapore	3631	2427	1497	1607	1630									
Hongkong	5070	3867	2937	3047	3070	1440								
C. LEEUWIN	4958	4020	3130	3472	5793	2317	3615							
Adelaide	6135	5197	4307	4649	4970	3501	4791	1177						
Melbourne	6440	5502	4612	4914	5275	3806	5096	1482	498					
Hobart Town	6591	5656	4766	5108	5429	4060	5250	1633	771	490				
Sydney	6904	5966	5076	5418	5739	4260	5557	1943	990	576	625			
Auckland	8000	7062	6172	6514	6835	5359	6656	3041	2057	1675	1510	1289		
Brisbane	7384	6443	5549	5891	6212	4733	6030	2423	1470	1056	1105	480	1342	
Wellington	7795	6857	5967	6309	8630	5154	6452	2856	1872	1489	1287	1231	543	1413

Singapore to Colombo [1566

VIA EASTERN ARCHIPELAGO.

	C. York	Brisbane	Sydney	Auckland	Melbourne	Wellington
Aden	6041	7287	7736	8456	8312	8548
Bombay	4862	6108	6557	7277	7133	7369
Calcutta	4080	5326	5775	6495	6351	6587
Singapore	2450	3695	4145	4865	4721	4957
Hongkong	2767	4013	4462	5182	5038	5274

THE NAVIGABLE MERCATORIAL DISTANCES IN NAUTICAL MILES BETWEEN ADEN AND THE PRINCIPAL PORTS OF THE EAST INDIES AND EAST COAST OF AFRICA.

Ports	ADEN	Maskat	Karachi	Bombay	Galle	Madras	Calcutta	Maulmain	PULO BRASSE	ANJER POINT	Keelings	Torres Strait, Cape York	Freemantle	C. LEEUWIN	St. Paul's I.	C. OF GOOD HOPE	Algoa Bay	Natal	Delagoa Bay	Cape St. Mary	Réunion or Bourbon	Mauritius	Rodrigue	Tamatave	Johanna	Zambesi River	Mozambique	Zanzibar	C. Guardafui	Mahe, Seychelles
Maskat	[illegible]																													
Karachi	1450	468																												
Bombay	1037	850	500																											
Galle	2134	1619	1372	930																										
Madras	2659	2144	1897	1460	530																									
Calcutta	3314	2799	2552	2110	1180	780																								
Maulmain	3326	2811	2504	2160	1230	1040	779																							
PULO BRASSE	3021	2506	2259	1817	887	997	1125	667																						
ANJER POINT	3821	3331	3084	2642	1712	1927	2165	1707	1140																					
Keelings	3468	3114	1854	2412	1482	1815	2160	1744	1077	644																				
Torres Strait	6041	5551	5314	4862	3932	4107	4130	3586	3110	2230	2740																			
Freemantle	4924	4690	4396	3940	3060	3392	3678	3220	2553	1676	1573	2547																		
CAPE LEEUWIN	4958	4772	4486	4020	3130	3472	3793	3335	2700	1810	1651	2667	176																	
St. Paul's I.	3734	3888	3852	3462	2676	3115	3726	3493	2826	2474	1878	3985	1912	1807																
C. OF GOOD HOPE	3918	4407	4635	4552	4309	4811	5439	5503	4980	5151	4494	6994	4902	4786	2843															
Algoa Bay	3541	4030	4258	4175	3932	4434	5062	5126	4603	4774	4117	6617	4525	4409	2490	375														
Natal	3162	3651	3879	3796	3597	4099	4727	4791	4268	4476	3822	6360	4374	4305	2369	751	386													
Delagoa Bay	2940	3413	3641	3556	3467	3969	4567	4661	4138	4346	3704	6283	4345	4307	2369	1040	675	293												
C. St. Mary	2751	3156	3309	3026	2804	3306	3934	3998	3475	3683	3041	5620	3696	3666	1820	1495	1128	793	673											
Bourbon	2306	2712	2823	2604	2181	2677	3305	3345	2839	3087	2427	5070	3281	3251	1566	2118	1751	1416	1286	623										
Mauritius	2335	2662	2748	2514	2063	2557	3185	3238	2706	2954	2294	4948	3203	3173	1547	2251	1884	1563	1443	770	136									
Rodrigue	2395	2634	2664	2378	1827	2312	2940	2960	2395	2597	1981	4413	2918	2888	1360	2558	2191	2064	1970	1307	684	353								
Tamatave	2206	2012	2765	2607	2321	2772	3400	3535	3058	3386	2766	5414	3650	3620	1921	2060	1693	1363	1233	570	371	470	793							
Johanna	1878	2361	2585	2509	2405	2919	3547	3592	3231	3660	3059	4325	4150	4120	2488	2051	1686	1300	1062	873	919	961	1211	736						
Zambesi River	2452	2061	3189	3139	3012	3525	4153	4199	3814	4235	3633	6253	4329	4299	2453	1493	1128	742	514	633	1256	1389	1940	1202	637					
Mozambique	2122	2611	2839	2789	2678	3194	3822	3865	3506	3912	3312	4575	4393	4363	2517	1791	1426	1040	828	707	1169	1211	1461	973	287	366				
Zanzibar	1720	2226	2450	2515	2580	3098	3726	3791	3450	4027	3433	6161	4562	4539	2898	2344	1979	1600	1381	1250	1329	1371	1621	1130	480	903	570			
C. Guardafui	376	913	1180	1303	1758	2283	2938	2950	2645	3445	3073	5624	4548	4579	3358	3537	3172	2786	2564	2375	1990	1959	[illegible]	1830	1502	2102	1746	1342		
Mahe, Seychelles	1410	1753	1893	1740	1620	2133	2761	2822	2442	3019	2485	5182	3769	3771	2376	2801	2434	2055	1818	1431	981	934	1012	887	[illegible]	1414	1083	1017	1030	
Diego Garcia	2035	2020	2048	1569	935	1409	2136	2336	1565	2013	1477	4162	2847	2873	1907	3416	3049	2714	2584	1921	1300	1167	912	1484	1655	2841	1915	2017	1709	1017

	Cape of G. Hope	Algoa Bay	Mauritius	Cape Leeuwin	Melbourne	St. Paul's I.	Prince Edward I.	Crozet	Kerguelen
St. Paul's I.	2843	2490	1547	1807	3142				
Prince Edward I.	1148	936	1856	3578	4726	2519			
Crozet Isles	1621	1351	1597	3031	4199	1279	511		
Kerguelen I.	2416	2134	1800	2176	3332	698	1265	769	
Heard I.	2572	2317	2111	2141	3126	896	1395	950	311

Heard I. & C. of Good Hope 257[illegible]
„ „ Cape Horn 70[illegible]8

VIA SUEZ CANAL

	Zanzibar	Mozambique	Mauritius	Mahe	Diego Garcia	Hongkong	Shanghai	Nagasaki	Yokohama
London	6350	6760	6970	6040	6720	9710	10 450	10 690	11,170
Liverpool	6305	6714	6027	5990	6677	9662	10 406	10 639	11,125
Plymouth	6078	6437	6700	5763	6450	9436	10 179	10 412	10,898
Gibraltar	5028	5437	5650	4713	5400	8386	9129	9362	9848

SOUTH AFRICAN PORTS

	Kiliman	Chinde River	Beira	Innamban	Delagoa B.	Cape St Mary
Mozambique	337	353	484	624	828	707
Kiliman		60	205	372	590	660
Chinde R.			145	321	540	644
Beira				244	485	670
Innamban					241	545
Delagoa B.						673

TO EAST INDIES VIA CAPE OF GOOD HOPE.

	LONDON	Liverpool	Plymouth	New York	Jamaica	Rio de Janeiro	Monte Video	CAPE
Liverpool	650							
Plymouth	317	344						
New York	3298	3022	2981					
Jamaica	4300	4000	4029	1484				
Rio de Janeiro	5192	5128	4918	4754	4081			
Monte Video	6179	6115	5905	5741	5068	1020		
C. OF GOOD HOPE	6156	6113	5882	6817	6369	3310	3700	
Mauritius	8417	8364	8133	9068	8620	5521	5851	2251
Freemantle	11,068	11,015	10 784	11 719	11 271	8172	8502	4902
Diego Garcia	9582	9529	9298	10 233	9785	6686	7016	3416
Mahe, Seychelles	8967	8914	8683	9618	9170	6071	6401	2801
Zanzibar	8505	8452	8221	9156	8708	5609	5939	2344
ANJER POINT	11 307	11 254	11,023	11,958	11 510	8411	8741	6151
Maulmain	11 659	11 606	11,375	12,310	11,862	8763	9093	5503
Calcutta	11,595	11 542	11,311	12 246	11 798	8699	9029	5439
Madras	10 967	10 914	10 683	11 618	11 170	8071	8401	4811
Galle	10,465	10 412	10 181	11 116	10 668	7569	7899	4309
Bombay	10,708	10 655	10 424	11 359	10 911	7812	8142	4552
Karachi	10,791	10 738	10 507	11 442	10 994	7895	8225	4635

	London	Liverpool	Plymouth	New York	Halifax	Bermuda	Jamaica	Barbados
Cape of Good Hope	6156	6113	5882	6817	6530	6127	6369	5292
Cape Horn	7401	7337	7132	6970	6830	6283	6297	5291

EAST INDIAN TO CHINESE AND JAPANESE PORTS.

	ADEN	Bombay	Galle	Madras	Calcutta	Maulmain	PULO BRASSE	Singapore	Anjer Pt.	Labuan	Bangkok	C. St. James, Saigon	Manila	Hongkong	Amoy	Shanghai	Peiho R.
Bombay	1637																
Galle	2134	930															
Madras	2664	1460	525														
Calcutta	3314	2110	1180	780													
Maulmain	3326	2098	1230	1040	779												
PULO BRASSE	3021	1817	887	997	1125	667											
Singapore	3631	2427	1497	1607	1630	1082	610										
Anjer Pt.	3821	2642	1712	1927	2165	1707	1040	507									
Labuan	4345	3141	2211	2321	2344	1796	1324	714	938								
Bangkok	4425	3221	2291	2401	2424	1876	1404	794	1269	1055							
C. St. James	4225	3021	2091	2201	2224	1676	1204	594	1000	571	601						
Manila	4954	3750	2820	2930	2953	2405	1933	1323	1551	664	1392	836					
Hongkong	5070	3867	2937	3047	3070	2522	2050	1440	1821	1031	1454	853	650				
Amoy	5353	4149	3219	3329	3352	2804	2246	1636	1945	1175	1083	1083	656	285			
Shanghai	5814	4602	3672	3782	3805	3257	2793	2183	2487	1693	2240	1639	1130	830	561		
Peiho R.	6372	5168	4238	4348	4371	3823	3351	2741	3045	2250	2780	2179	1690	1381	1117	605	
Nagasaki	6047	4843	3913	4023	4046	3498	3026	2416	2719	1924	2447	1853	1385	1074	801	467	736
Yokohama	6533	5349	4399	4509	4532	3984	3512	2902	3179	2332	2981	2386	1768	1602	1344	1060	1361

Yokohama – Nagasaki: 692

THE NAVIGABLE MERCATORIAL DISTANCES IN NAUTICAL MILES BETWEEN PULO BRASSE AND THE PRINCIPAL PORTS OF CHINA AND JAPAN.

Ports	Pulo Brasse	Singapore	Anjer Point	Batavia	Labuan	Bangkok. Saigon	C. St. James	Manila	Zebu	Hongkong	Canton	Swatau	Tamsui, Formosa Id.	Amoy. Fuchau	River Min	Wanchu	Ningpo	Shanghai	Chifu. Tientsin	Peiho R.	Newchang	Nagasaki	Kobe	Yokohama	Hakodate	Vladivostock	Nikolaevsk	Petropaulski	Nafa Kiang, Luchu Islands	San Francisco
Singapore ..	610																													
Anjer Point ..	1040	507																												
Batavia ..	1119	509	71																											
Labuan ..	1324	714	938	919																										
Bangkok ..	1404	794	1269	1248	1055																									
Cape St. James	1204	594	1000	990	571	601																								
Manila ..	1933	1323	1551	1583	664	1392	836																							
Zebu ..	1942	1332	1570	1551	632	1592	1092	386																						
Hongkong ..	2050	1440	1821	1813	1031	1454	853	650	1002																					
Canton ..	2106	1496	1887	1879	1097	1510	909	723	1083	79																				
Swatau ..	2163	1553	1881	1866	1091	1575	975	630	961	170	249																			
Tamsui ..	2378	1768	2086	2071	1259	1828	1227	730	1061	448	527	278																		
Amoy ..	2246	1636	1945	1929	1175	1683	1083	696	1046	285	364	120	188																	
River Min ..	2417	1807	2110	2095	1320	1856	1255	786	1120	455	534	297	134	199																
Wanchu ..	2545	1935	2238	2223	1443	1989	1388	914	1248	583	662	425	197	320	200															
Ningpo ..	2706	2096	2399	2384	1604	2144	1543	1074	1408	743	822	582	348	480	361	233														
Shanghai ..	2793	2183	2487	2472	1693	2240	1639	1130	1497	824	903	677	453	561	445	318	157													
Chifu ..	3158	2548	2852	2837	2062	2582	1981	1481	1870	1197	1276	1050	826	934	827	691	530	527												
Peiho River ..	3351	2741	3045	3030	2250	2780	2179	1690	2054	1381	1460	1234	1010	1117	1002	875	714	711	197											
Newchang ..	3354	2744	3048	3033	2254	2784	2183	1691	2058	1385	1464	1238	1014	1122	1006	879	718	715	216	242										
Nagasaki ..	3026	2416	2719	2704	1924	2447	1853	1285	1385	1074	1153	903	631	801	685	566	462	470	552	736	740									
Kobe ..	3253	2643	3169	3154	2235	2750	2151	1569	1603	1372	1451	1180	935	1109	1017	903	787	787	817	1000	1005	381								
Yokohama ..	3512	2902	3179	3164	2332	2980	2386	1768	1736	1602	1654	1444	1156	1344	1237	1120	1035	1068	1170	1360	1360	692	356							
Hakodate ..	3881	3271	3751	3736	2817	3235	2634	2070	2185	1825	1904	1758	1398	1556	1449	1321	1176	1176	1224	1408	1412	802	890	508						
Vladivostock ..	3632	3022	3378	3363	2583	3069	2468	1944	2044	1670	1749	1509	1250	1407	1300	1176	1057	1057	1038	1222	1226	659	799	927	419					
Nikolaevsk ..	4377	3767	4124	4109	3329	3814	3213	2690	2790	2415	2494	2254	1995	2152	2045	1921	1799	1799	1805	1989	1993	1405	1515	1273	765	850				
Petropaulski ..	4854	4244	4521	4506	3674	4323	3728	3110	3078	2900	2979	2818	2458	2716	2509	2381	2230	2230	2284	2468	2472	1862	1950	1402	1066	1341	836			
Nafa Kiang ..	2621	2050	2557	2538	1619	2130	1530	932	987	806	885	636	358	546	467	406	405	477	785	969	973	400	675	880	1202	1059	1805	2212		
San Francisco ..	8300	7690	7926	7909	6990	7802	7201	6566	6370	6444	6523	6244	5966	6154	5986	5875	5787	5809	5930	6114	6118	5426	5092	4732	4469	4888	3949	3412	5618	
Sydney ..	4642	4276	3753	3824	3830	4820	4280	3915	3443	4462	4580	4600	4620	4600	4655	4600	4670	4700	5030	5224	5230	4490	4450	4380	4740	5160	5505	5264	4240	6463

Anjer Point to C. of Good Hope .. 5141
" C. Leeuwin .. 1794
Singapore to C. Leeuwin 2317

Ports	VIA SUEZ CANAL: London	Liverpool	Plymouth	New York	Halifax	Bermuda	Jamaica	Barbados	VIA CAPE: Rio	Monte Video
Pulo Brasse	7,660	7,613	7,386	9.592	9.046	9 304	10 299	9 581	8 240	8 570
Anjer Point	8,460	8,413	8.186	10 392	9,846	10 104	11 099	10 381	8 411	8,741
Aden ..	4.640	4.592	4.365	6.571	6.025	6 283	7 278	6 560	7 178	7.508
Adelaide ..	10 770	10.727	10 500	12 706	12,160	12 706	13 413	12 695	8 856	9.193
Melbourne ..	11,080	11.032	10 805	13 011	12 465	13,011	13 718	13 000	9 043	9.380
Sydney ..	11,540	11.496	11 269	13 475	12 929	13 475	14 182	13 464	9 482	9 819
Hobart ..	11 230	11.183	10.956	13 162	12,616	13 162	13.869	13 151	9 042	9 379
Auckland ..	12 640	12.502	12 365	14 571	14 025	14 571	15 278	14 560	10,502	10 839

	Torres Strait. Cape York
Singapore	2.450
Batavia ..	2,160
Bangkok	3.120
Manila ..	2,220
Hongkong	2 767

	SOUTH OF CAPE: Rio	Monte Video
Adelaide ..	8 708	8 907
Melbourne	8,895	8 984
Sydney ..	9.335	9 424
Hobart ..	8 893	8 982
Auckland	10 351	10 440

ADEN, CAPE OF GOOD HOPE, AND CAPE HORN, TO THE AUSTRALIAN PORTS. See p. 641.

Ports	Aden	C. of Good Hope (via lat. 46° S.)	Fremantle	C. LEEUWIN	Albany	Adelaide	Melbourne	Hobart	Sydney	Newcastle	Brisbane	Rockhampton	Townsville	Cook Town	Thursday Id. & C. York	Port Darwin	Auckland	Wellington	Lyttleton	Otago
C. of Good Hope	3018																			
Fremantle ..	4924	4774																		
C. LEEUWIN ..	4958	4665	176																	
Albany ..	5125	4761	343	167																
Adelaide ..	6135	5574	1353	1177	1019															
Melbourne ..	6440	5761	1658	1482	1324	498														
Hobart ..	6591	5759	1809	1633	1475	771	490													
Sydney ..	6904	6201	2119	1943	1785	990	576	625												
Newcastle ..	6969	6266	2184	2008	1850	1055	641	690	65											
Brisbane ..	7384	6681	2599	2423	2265	1470	1056	1105	480	430										
Rockhampton	7650	6946	2864	2688	2530	1735	1321	1370	745	695	334									
Townsville ..	8000	7298	3216	3040	2882	2087	1673	1722	1097	1047	688	375								
Cook Town ..	8240	7538	3456	3280	3122	2327	1913	1962	1337	1278	928	615	240							
Thursday Id. ..	8635	7933	3851	3675	3517	2722	2308	2357	1732	1682	1323	1010	635	395	35					
Port Darwin ..	5378	6240	1815	1951	2109	3158	3033	3082	2457	2407	2048	1735	1360	1120	725					
Auckland ..	8000	7221	3218	3042	2834	2058	1675	1510	1289	1274	1342	1541	1893	2133	2528	3253				
Wellington ..	7314	6998	3032	2856	2698	1872	1489	1287	1231	1235	1413	1641	1994	2233	2628	3353	513			
Lyttleton ..	7948	7132	3166	2990	2832	2006	1628	1421	1366	1369	1547	1775	2127	2376	2762	3478	666	166		
Otago ..	8111	7295	3329	3153	2995	2161	1788	1584	1529	1532	1710	1938	2230	2530	2925	3750	835	327	190	
Cape Horn ..	12048	10240	7286	7110	6932	6078	5871	5439	5782	5823	6025	6253	6605	6845	7240	7965	4815	4612	4510	4600

Aden to C. Horn 7710
C. of Good Hope to C. Horn 3791

Auckland, Wellington, Lyttleton, Otago: To Australian Ports and Hobart, via Cook Strait. Cape Horn, via latitude 52° S.

AUSTRALIAN PORTS TO ISLAND PORTS IN THE PACIFIC OCEAN.

Ports	MELBOURNE	Sydney	Hobart	Auckland	Brisbane	Torres Str. Thursday I.	Noumea	Levuka	Tongatabu	Apia	Vanua Lava	Port Praslin	Tahiti
Sydney ..	576												
Hobart ..	490	625											
Auckland ..	1675	1289	1510										
Brisbane ..	1056	480	1105	1342									
Thursday I. ..	2306	1730	2355	2450	1281								
Noumea ..	1594	1063	1609	1006	805	1601							
Levuka ..	2289	1786	2248	1162	1583	2214	807						
Tongatabu ..	2402	1934	2322	1101	1769	2549	1103	400					
Apia ..	2849	2400	2795	1585	2272	2742	1421	614	493				
Vanua Lava ..	2095	1517	2135	1478	1161	1517	622	723	1114	1211			
Port Praslin ..	2187	1602	2227	2053	1259	1146	1181	1413	1814	1818	700		
Tahiti ..	3742	3338	3595	2221	3238	4002	2561	1902	1458	1284	2485	3111	
Honolulu ..	4956	4410	4950	3805	4076	4266	3393	2715	2751	2269	2931	3120	2400

SOUTH OF NEW ZEALAND.

	Freemantle	Albany	Adelaide	Melbourne	Hobart	Sydney
Lyttleton	3010	2676	1972	1566	1261	1411
Otago ..	2829	2495	1791	1385	1080	1230

THE NAVIGABLE MERCATORIAL DISTANCES IN NAUTICAL MILES BETWEEN CAPE HORN AND THE PRINCIPAL PORTS OF THE WEST COAST OF SOUTH AMERICA.

Ports	Cape Horn	Cape Virgins	Sandy Point	Cape Pillar	Port Henry	C. Tres Montes	Port St. Carlos	Port Montt	Valdivia	Lota	Talcahuano	Valparaiso	Juan Fernandez	Coquimbo	Huasco	Caldera	Antifogasta	Cobija	Iquique	Arica	Islay	Pisco	Callao	Chimbote	PAYTA	Guayaquil	Manta	Buenaventura	PANAMA
Cape Virgins ..	292																												
Sandy Point ..	403	111																											
Cape Pillar ..	357	304	193																										
Port Henry ..	526	473	362	169																									
C. Tres Montes.	712	659	548	355	186																								
Port St. Carlos..	1041	988	877	684	515	329																							
Port Montt ..	1083	1030	919	726	557	371	55																						
Valdivia.. ..	1156	1103	992	799	630	444	123	178																					
Lota	1335	1282	1171	978	809	623	303	358	187																				
Talcahuano ..	1362	1309	1198	1005	836	650	330	385	214	37																			
Valparaiso ..	1578	1525	1414	1221	1052	866	546	601	430	261	238																		
Juan Fernandez	1530	1477	1366	1173	1004	824	550	605	455	349	345	369																	
Coquimbo ..	1762	1709	1598	1405	1236	1050	730	785	611	450	427	191	444																
Huasco	1852	1799	1688	1495	1326	1140	820	875	704	536	513	275	501	98															
Caldera	1942	1889	1778	1585	1416	1230	910	965	794	626	603	365	567	188	90														
Antifogasta ..	2147	2094	1983	1790	1621	1435	1115	1170	999	831	808	570	741	393	295	205													
Cobija	2223	2160	2059	1866	1697	1511	1191	1246	1075	907	884	646	802	469	371	281	79												
Iquique	2354	2301	2190	1997	1828	1642	1322	1377	1206	1054	1031	793	937	616	518	428	230	151											
Arica	2455	2402	2291	2098	1929	1743	1423	1478	1307	1137	1107	888	1021	711	613	523	330	251	100										
Islay	2530	2477	2366	2173	2004	1818	1500	1555	1384	1223	1193	975	1071	790	700	620	427	360	230	150									
Pisco	2715	2662	2551	2358	2189	2003	1696	1751	1579	1425	1400	1185	1210	1015	941	866	680	640	530	450	321								
Callao	2812	2759	2648	2455	2286	2100	1794	1849	1680	1519	1495	1295	1305	1125	1051	976	790	750	640	580	431	120							
Chimbote ..	2997	2944	2833	2640	2471	2285	1980	2035	1867	1707	1683	1485	1475	1315	1243	1170	990	950	840	780	631	320	200						
PAYTA	3245	3192	3081	2888	2719	2533	2230	2285	2127	1974	1950	1770	1718	1600	1528	1455	1275	1235	1125	1065	916	605	490	300					
Guayaquil ..	3463	3410	3299	3106	2937	2751	2448	2503	2345	2192	2168	1988	1936	1818	1746	1673	1493	1453	1343	1283	1134	823	708	518	218				
Manta	3507	3454	3343	3150	2981	2795	2492	2547	2389	2236	2212	2032	1988	1862	1798	1717	1537	1497	1387	1327	1178	867	752	562	262	231			
Buenaventura ..	3877	3824	3713	3520	3351	3165	2862	2917	2759	2606	2582	2402	2350	2232	2160	2087	1907	1867	1759	1697	1548	1237	1122	932	632	601	375		
PANAMA ..	4097	4044	3933	3740	3571	3385	3082	3137	2979	2826	2802	2622	2570	2452	2380	2307	2127	2087	1977	1917	1768	1457	1342	1152	852	821	595	345	
Galapagos Ids. (Charles Island)	3537	3484	3373	3180	3014	2840	2583	2638	2483	2340	2322	2171	2042	2021	1951	1900	1763	1722	1623	1562	1412	1121	1023	847	605	693	583	861	914

IMPORTANT DISTANCES.

	London	Liverpool	Plymouth	New York	Jamaica	Rio	Monte Video	Valparaiso	Honolulu	Fiji Islands	San Francisco
Cape Horn ..	7401	7337	7132	6970	6297	2261	1360	1578	6598	5566	6342
C. of Good Hope	6156	6113	5882	6817	6369	3310	3700	5369	10 389	7914	10.133
Panama	4729	4666	4576	10,873	597	4288	5275	2622	4692	6278	3243
Aden	4635	4592	4365	6571	7278	7178	7508	9277	14 300	13 436	14.051
Anjer Point ..	11,307	11.254	11 023	11.958	11,510	8411	8741	10.520	15.540	14 680	15.284
Gibraltar ..	1320	1280	1050	3256	3693	4200	5187	[illegible]	[illegible]	12 143	12.369

PORTS ON THE WEST COAST OF NORTH AMERICA

	San Fran.	Monterey	Los Angeles	San Diego	Magdalena	Clipperton Rk.
Sandy Point ..	6178	6104	5868	5812	5240	4377
Valparaiso ..	5145	5070	4815	4737	4165	3373
Coquimbo ..	5016	4936	4681	4603	4031	3257
Callao.. ..	3990	3913	3558	3580	3010	2333
Payta	3522	3447	3192	3114	2542	1905
Los Angeles ..	364	290	—	82	660	1495
Clipperton Rk.	1811	1737	1495	1415	880	—

THE PRINCIPAL PORTS OF THE PACIFIC OCEAN TO EUROPE, VIA LAT 52° S., AND STRAIT OF MAGELLAN.*

	London	Liverpool	Plymouth	Gibraltar	New York	Rio de Janeiro	Monte Video	CAPE HORN	Sandy Point	Valparaiso	Coquimbo	Callao	Guayaquil	Panama	Acapulco	Mazatlan	San Francisco	Esquimalt	Honolulu	Tahiti
Liverpool ..	647																			
Plymouth ..	317	346																		
Gibraltar ..	1323	1277	1050																	
New York ..	3298	3 22	2981	3256																
Rio de Janeiro ..	5192	5128	4918	4200	4754															
Monte Video ..	6179	6115	5905	5187	3256	1020														
CAPE HORN ..	7401	7337	7127	6416	6963	2201	1360													
Sandy Point ..	7379	7315	7105	6391	6940	2217	1295	403												
Valparaiso ..	8793	8728	8519	7801	8354	3631	2709	1578	1414											
Coquimbo ..	8977	8913	8703	7985	8538	3815	2893	1762	1598	191										
Callao ..	10027	9962	9753	9035	9588	4865	3943	2812	2648	1295	1125									
Guayaquil ..	10678	10613	10404	9686	10239	5516	4594	3463	3299	1988	1818	708								
Panama ..	11312	11247	11038	10320	10873	6150	5228	4097	3933	2622	2452	1342	821							
Acapulco ..	11927	11863	11653	10935	11488	6765	5843	4712	4548	3381	3231	2191	1737	1411						
Mazatlan ..	12397	12333	12123	11405	11958	7235	6313	5182	5018	3878	3737	2720	2282	1983	572					
San Francisco ..	13566	13502	13292	12574	13127	8395	7473	6342	6178	5145	5016	3990	3558	3243	1832	1341				
Esquimalt ..	14297	14233	14023	13305	13858	9135	8213	7082	6918	5911	5761	4730	4283	3968	2557	2066	740			
Honolulu ..	13817	13753	13543	12825	13378	8655	7733	6598	6438	5942	5842	5163	4864	4692	3304	2841	2086	2343		
Tahiti ..	11706	11642	11432	10714	11267	6544	5622	4434	4327	4308	4311	4196	4234	4475	3583	3513	3652	4234	2400	
Easter Island	9763	9690	9489	8771	9324	4601	3679	2526	2384	1993	2001	2026	2258	2750	2965	3045	3962	4688	4046	2295

* The passage made v. C. Horn adds 100 m. to these distances

	Yokohama	Shanghai	Hongkong	Cape York	Fiji Islands	Brisbane	Sydney	Auckland	Wellington	Hobart	Melbourne	Adelaide
London ..	16,662	17,308	17,361	14,423	12 871	13,299	13,086	12 119	11 916	12 744	13,142	13,382
Liverpool ..	16 625	17,271	17,324	14,391	12.833	13 262	13 049	12 082	11 879	12,707	13,105	13 345
Plymouth ..	16,408	17 054	17.107	14.174	12.616	13 045	12,832	11,865	11 662	12 489	12,888	13,128
Gibraltar ..	15,682	16.328	16,381	13 448	11 890	12,319	12,106	11 139	10,936	11,763	12,162	12 40[illegible]
New York ..	16,229	16 875	16 928	13,995	12 437	12,866	12,653	11 686	11,483	12,310	12,709	12 949
Rio	11,508	12,154	12.207	9274	7716	8145	7932	6965	6762	7589	7988	8228
Monte Video	10,586	11.232	11,285	8352	6794	7223	7010	6043	5840	6667	7066	7306

CAPE COLONY AND AUSTRALIAN PORTS, VIA LAT. 46° AND 26° S

Ports	Albany	Adelaide	Melbourne	Hobart	Sydney	Auckland	Wellington	Otago
Natal ..	4459	5332	5519	5517	5959	6975	6725	6419
Algoa B.	4496	5369	5556	5554	5996	7012	6762	6456
Cape ..	4700	5574	5761	5760	6200	7220	6970	6660
Natal ..	4845	5855	6160	6311	6621	7719	7515	7340
Algoa B.	5127	6137	6442	6503	6903	8001	7797	[illegible]
Cape ..	5502	6512	6817	6986	7278	8376	8172	7997

THE NAVIGABLE MERCATORIAL DISTANCES IN NAUTICAL MILES BETWEEN PANAMA AND THE PRINCIPAL PORTS OF THE PACIFIC OCEAN.

DISTANCES BETWEEN STATIONS OF "ALL BRITISH" CABLE.

Vancouver to Fanning Island	3355
Fanning Island to Suva, Fiji	1801
Suva, Fiji, to Norfolk Island	839
Norfolk Island to Brisbane	800
Norfolk Island to New Zealand, Doubtless Bay ..	453

VIA SUEZ CANAL.

	Yokohama	Shanghai	Hongkong	Manila	Singapore	Batavia	Brisbane	Sydney	Auckland	Wellington	Hobart	Melbourne	Adelaide	Fiji
London ..	11.170	10 450	9710	9590	8270	8530	11.927	11.540	12 640	12,450	11 230	11,080	10,770	12.890
Liverpool ..	11,125	10 406	9662	9546	8223	8484	11,884	11,496	12 592	12,387	11,183	11 032	10,727	12,817
Plymouth ..	10 898	10,171	9435	9319	7996	8257	11 657	11 269	12,364	12.160	10 956	10,805	10,500	12 590
New York ..	13.104	12,377	11.641	11,525	10 202	10.463	13 863	13.475	14.571	14,366	13.162	13,011	12 706	14 796
Jamaica ..	13,811	13.084	12.348	12.232	10,909	11.170	14 570	14.182	15.278	15,073	13,869	13,718	13.413	15,503

VIA CAPE OF GOOD HOPE (BY LAT. 46° S. TO AUSTRALIAN PORTS).

	Yokohama	Shanghai	Hongkong	Manila	Singapore	Batavia	Brisbane	Sydney	Auckland	Wellington	Hobart	Melbourne	Adelaide	Fiji
London ..	14 476	13,794	13 118	12 848	11,820	11.368	12 836	12 356	13.376	13.154	11.016	11,917	11 730	14,070
Liverpool ..	14 433	13 741	13.075	12 805	11,774	11 325	12,793	12,313	13 333	13.083	11 873	11 874	11 687	14 027
Plymouth ..	14 202	13 510	12 844	12 574	11.546	11,094	12,562	12,082	13 102	12.852	11 642	11,643	11,456	13,796
New York ..	15 137	14 445	13 779	13 509	12,481	12,029	13.497	13,017	14 037	13.787	12,577	12.578	12 391	14 731
Jamaica ..	14 689	13 997	13 331	13 061	12 033	11,581	12 049	12 569	13 589	13.339	12,129	12,130	11.943	14 283
Rio de Jan.	11 590	10 898	10 232	9962	8934	8482	9950	9470	10 490	10 240	9030	9031	8844	11.184
Monte Video	11 920	11.228	10 562	10 292	9264	8812	10 280	9800	10 820	10 570	9360	9361	9174	11.514
C. of G. Hope	8320	7628	6962	6692	5664	5212	6680	6200	7220	6998	5760	5761	5574	7946

PANAMA

Ports	Panama	Chirique	Punta Burica	Punta Arenas	San Juan del Sur	Realejo	Port La Union	Acajutla	San Jose de Guatemala	Salina Cruz	Acapulco	MANZANILLA
Chirique ..	271											
Punta Burica ..	277	43										
Punta Arenas ..	452	218	175									
San Juan del Sur	591	357	314	169								
Realejo	663	429	386	260	104							
Port La Union ..	731	497	454	328	176	72						
Acajutla	810	576	533	407	267	171	149					
S. Jose de Guatemala	877	643	600	474	338	242	220	71				
Salina Cruz ..	1158	924	881	755	624	528	506	357	286			
Acapulco ..	1411	1177	1134	1008	884	797	776	626	555	300		
MANZANILLA ..	1703	1469	1426	1300	1176	1089	1067	918	847	592	292	
San Blas ..	1889	1655	1662	1492	1362	1275	1253	1104	1033	778	478	186
Mazatlan ..	1983	1749	1706	1580	1456	1369	1347	1198	1127	872	572	280
La Paz	2181	1947	1904	1778	1654	1567	1545	1396	1325	1070	770	478
Guaymas ..	2355	2121	2078	1952	1828	1741	1719	1570	1499	1244	944	652
San Diego ..	2727	2493	2450	2324	2200	2113	2091	1942	1871	1616	1316	1120
Monterey ..	3161	2927	2884	2758	2634	2547	2525	2376	2305	2050	1750	1458
San Francisco ..	3243	3009	2966	2840	2716	2629	2607	2458	2387	2132	1832	1540
Columbia River	3789	3555	3512	3386	3262	3175	3153	3004	2933	2678	2378	2086
Esquimalt ..	3968	3734	3691	3565	3441	3354	3332	3183	3112	2857	2557	2265
Vancouver ..	4041	3807	3764	3638	3514	3427	3405	3256	3185	2930	2630	2338
Port Simpson ..	4318	4084	4041	3915	3791	3704	3682	3533	3462	3207	2907	2615
Sitka	4520	4286	4243	4114	3993	3906	3884	3735	3664	3409	3109	2817
Iliuliuk ..	5280	5046	5003	4877	4755	4666	4644	4495	2424	4169	3869	3577
Honolulu ..	4692	4458	4415	4275	4185	4086	4060	3928	3854	3024	3304	3132
Nukahiva ..	3817	3120	3077	3012	2977	3395	3392	3300	3236	3050	2847	2699
Tahiti	4475	4285	4231	4175	4153	4125	4115	4000	3961	3801	3583	3449
Easter Islands ..	2750	2628	2588	2630	2657	2690	2733	2687	2687	2725	2695	2782
Galapagos Ids...	914	760	724	764	807	855	900	900	927	1091	1230	1475

Ports	San Blas	Mazatlan	La Paz	Guaymas	San Diego	Monterey	San Francisco	Columbia River	Esquimalt	Vancouver	Port Simpson	Sitka	Iliuliuk, Aleutian Is.	Honolulu	Nukahiva	Tahiti	Easter Id
Mazatlan ..	113																
La Paz	327	243															
Guaymas ..	495	382	218														
San Diego ..	891	825	776	973													
Monterey ..	1325	1259	1210	1407	363												
San Francisco ..	1407	1341	1292	1489	445	82											
Columbia River	1953	1887	1838	2035	991	628	564										
Esquimalt ..	2132	2066	2017	2214	1170	807	740	208									
Vancouver ..	2205	2139	2090	2287	1243	880	813	271	77								
Port Simpson ..	2482	2416	2367	2564	1520	1157	1090	598	529	460							
Sitka	2684	2618	2569	2766	1722	1359	1292	814	751	680	272						
Iliuliuk ..	3449	3384	3334	3527	2472	2122	2062	1703	1669	1600	1333	1079					
Honolulu ..	2891	2841	2791	2984	2261	2095	2086	2241	2343	2416	2395	2363	2295				
Nukahiva ..	2732	2762	2749	2942	2816	2915	2971	3423	3603	3676	3818	3981	3976	2095			
Tahiti	3483	3513	3500	3693	3532	3604	3652	4061	4234	4307	4429	4525	4430	2380	751		
Easter Islands ..	2028	3045	3110	3310	3615	3881	3962	4509	4688	4761	4985	5195	5714	4046	2054	2295	
Galapagos Ids. (Charles I.)	1655	1755	1953	2127	2499	2933	3015	3561	3740	3813	4090	4292	5069	4177	2995	3608	1881

Vancouver—Esquimalt to Cape Flattery 60

CENTRAL AMERICAN PORTS.

	Punta Arena	Port La Union	San Jose	Salina Cruz	Acapulco	Manzanilla
Payta ..	931	1190	1291	1532	1727	1993
Guayaquil	915	1175	1286	1528	1738	2013
Manta ..	700	961	1086	1328	1559	1829
Callao ..	1421	1680	1781	2022	2191	2464
Coquimbo	2531	2790	2864	3093	3231	3505
Valparaiso	2701	2960	3025	3274	3381	3644
Sandy Pt.	3990	4212	4280	4464	4548	4774

DISTANCES BETWEEN THE PRINCIPAL PORTS OF THE PACIFIC OCEAN.

BY SOUTHERN ROUTE (Cape Horn, Sandy Point, Valparaiso, Coquimbo, Callao).

	Cape Horn	Sandy Point	Valparaiso	Coquimbo	Callao	Guayaquil	Panama	Acapulco	Mazatlan	San Fran.	Esquimalt	Honolulu	Tahiti	Petropaulski	Yokohama	Shanghai	Hongkong	Nukahiva	Fiji Ids. (Levuka)	Brisbane	Sydney	Auckland	Melbourne	Wellington
Petropaulski ..	9795	9728	9988	10068	10533	7038	6681	5285	4715	3412	2983	2768	5023											
Yokohama ..	9458	9391	9602	9700	10147	8298	8019	6544	6000	4732	4400	3393	5138	1402										
Shanghai ..	100[illegible]4	9937	10248	10346	10793	9406	9158	7671	7155	5809	5429	4416	5945	2222	1068									
Hongkong ..	1[illegible]061	9994	10305	10403	10850	9902	9726	8256	7681	6444	6093	4860	6140	2900	1602	894								
Nukahiva ..	4565	4500	4758	4856	5303	3655	3817	2847	2762	2971	3603	2095	751	4879	5277	6179	6498							
Fiji Islands ..	5566	5500	6000	6100	6643	6081	6278	5242	5025	4703	5063	2715	1902	4365	3891	4457	4491	2439						
Brisbane ..	5995	5928	6533	6669	7229	7488	7762	6774	6544	6156	6420	4096	3238	4835	3915	4230	4013	3948	1583					
Sydney ..	5782	5715	6303	6439	7046	7505	7839	6940	6780	6463	6764	4410	3338	5264	4380	4700	4462	4081	1786	480				
Auckland ..	4815	4748	5333	5469	5904	6219	6590	5814	5739	5676	6121	3805	2221	5455	4800	5164	5182	2976	1162	1309	1260			
Melbourne ..	5838	5771	6392	6528	7164	7844	8217	7340	7185	6995	7310	4956	3742	5840	4956	5276	5038	4516	2289	1056	576	1675		
Wellington ..	4629	4559	5150	5286	5846	6272	6902	5920	5853	5890	6360	4057	2340	5720	5025	5364	5274	3091	1487	1383	1200	528	1470	
Hobart ..	5440	5372	5960	6096	6858	7374	7914	7223	7105	6900	7293	4950	3595	5890	5005	5325	5087	4376	2248	1105	625	1531	490	1281

BY NORTHERN ROUTE.

	San Francisco	Esquimalt
Yokohama	4470	4225
Shanghai	5460	5080
Hongkong	6000	5750

THE NAVIGABLE DISTANCES IN NAUTICAL MILES BETWEEN PORTS IN THE MEDITERRANEAN SEA AND THE PRINCIPAL PORTS OF THE WORLD.

WESTERN MEDITERRANEAN PORTS.

	LONDON	Liverpool	Plymouth	Southampton																												
Ushant ..	380	373	120	216	Ushant & Bordeaux, 300
Lisbon ..	1035	1000	764	865	645	Lisbon & Bordeaux, 7[illegible]8
Cadiz ..	1260	1226	990	1089	872	244	Cadiz & Tangier, 60
GIBRALTAR	1320	1280	1050	1146	930	300	75	GIBRALTAR & Port Mahon, 533
Malaga ..	1381	1338	1111	1205	991	356	136	61	Malaga & Nice, 720 Nice & Civita Vecchia, 230
C. de Gata	1477	1435	1208	1302	1088	453	233	158	107	C. de Gata & Tangier, 137
Cartagena ..	1556	1513	1286	1380	1166	531	311	236	185	78	Cartagena
C. San Antonio	1654	1511	1384	1478	1264	629	409	334	283	176	104	C. San Antonio
Barcelona ..	1832	1789	1562	1656	1442	807	587	512	461	354	282	178	Barcelona
Marseilles ..	2007	1964	1737	1831	1617	982	762	690	636	529	457	353	184	Marseilles
Toulon ..	2017	1974	1747	1841	1627	992	772	697	646	539	467	363	196	39	Toulon
Genoa ..	2168	2125	1898	1992	1778	1143	923	852	797	690	614	513	350	198	166	Genoa
Spezzia ..	2187	2144	1917	2011	1797	1162	942	867	816	709	635	538	379	223	191	51	Spezzia
Leghorn ..	2183	2140	1913	2007	1793	1158	938	863	812	705	631	536	380	237	198	79	40	Leghorn
Bonifacio ..	2070	2027	1800	1804	1680	1045	825	750	699	592	526	440	311	210	178	198	176	147	Bonifacio
Naples ..	2295	2252	2025	2119	1905	1270	1050	980	924	817	749	681	550	449	417	336	303	263	239	Naples & Civita Vecchia, 145
C. Spartivento	2018	1975	1748	1842	1628	993	773	698	649	542	474	406	342	322	296	357	337	307	198	275	C. Spartivento
Palermo ..	2233	2190	1963	2057	1843	1208	988	913	857	750	600	624	502	495	463	426	392	356	285	168	220	Palermo & Nice, 440
MESSINA ..	2345	2302	2075	2169	1955	1320	1100	1025	974	867	800	730	674	580	546	490	454	416	370	175	332	118	MESSINA
Syracuse ..	2350	2307	2080	2174	1960	1325	1105	1030	971	864	814	755	699	649	615	559	523	485	439	243	387	187	69	Syracuse
C. Passaro ..	2320	2277	2050	2144	1930	1295	1075	1000	941	834	784	725	669	634	662	589	553	515	424	274	326	217	100	30	C. Passaro & Philippeville, 413
Malta ..	2304	2201	2034	2128	1914	1279	1059	984	929	822	768	709	665	634	602	585	551	510	424	327	316	223	153	83	53	Malta & Santorin, 540
C. Bon ..	2121	2077	1850	1944	1730	1005	875	800	745	658	584	525	489	468	446	452	425	391	284	270	150	140	251	230	200	184	C. Bon
Tunis ..	2108	2065	1838	1932	1718	1083	863	788	735	678	574	515	475	462	440	471	444	411	302	306	147	182	293	268	238	222	38	Tunis
Algiers ..	1728	1685	1460	1554	1340	705	485	410	358	251	200	181	279	408	400	511	537	528	396	577	302	504	618	619	589	573	389	380	Algiers & Philippeville, 196
Venice ..	2083	2942	2715	2809	2595	1960	1740	1665	1614	1507	1440	1370	1313	1217	1185	1129	1093	1055	1010	814	971	757	650	668	690	740	890	928	1279	Venice & Ancona, 124
Constantinople	3120	3077	2850	2944	2730	2095	1875	1800	1749	1642	1583	1525	1478	1382	1350	1294	1258	1220	1174	980	1136	922	805	794	800	830	1000	1038	1389	1165	Constantinople
PORT SAID ..	3240	3197	2910	3064	2850	2215	1935	1920	1864	1757	1703	1644	1586	1520	1482	1426	1390	1352	1306	1111	1278	1054	936	921	921	940	1119	1157	1503	1319	795	PORT SAID

GIBRALTAR AND PORTS IN THE ATLANTIC AND WESTERN HEMISPHERE.

St. Michaels	Madeira	St. Vincent	Fayal	Sierra Leone	Bermuda	Quebec	Halifax	Boston	New York	Baltimore	Charleston	New Orleans	St. Thomas	Havana	Jamaica	Colon
1010	610	1565	1121	1977	2068	3221	2710	3084	3256	3555	3701	4817	3336	4237	3963	4263

Barbados	Demerara	Bahia	Rio	Monte Video	Ascension	St. Helena	Sandy Point	Cape Horn	Valparaiso	Callao	Tahiti	Honolulu	S. Francisco
3245	3397	3516	4200	5187	2857	3470	6391	6416	7801	9035	10,714	12,825	12,5[illegible]

GIBRALTAR AND EUROPEAN PORTS.

Oporto	Bordeaux	Brest	Cherbourg	Dover	Antwerp	Hamburg	Christiania	Copenhagen	Bergen	Danzig	Memel	Revel	Stockholm	S. Petersburg
345	1010	927	1092	1230	1365	1630	1855	1900	1815	2165	2210	2412	2320	2590

Havre	Belfast	Cardiff	Cork	Glasgow	Hull	Leith	Newcastle	Dundee
1165	1296	1152	1090	1388	1440	1620	1513	1634

EASTERN MEDITERRANEAN PORTS.

Port Said to Suez 87

	LONDON	Liverpool	Plymouth	Southampton	Gibraltar	Marseilles	Malta	Messina	Cape Passaro	Venice	Constantinople	Port Said	Cape Bon																					
Brindisi ..	2605	2562	2335	2429	1285	840	362	260	306	380	785	940	506	Brindisi
Trieste ..	2977	2933	2707	2801	1657	1212	734	632	678	60	1157	1311	878	372	Trieste
Corfu ..	2618	2575	2348	2442	1298	853	365	273	312	488	697	840	512	116	478	Corfu
Patras ..	2657	2614	2387	2481	1337	892	380	312	340	620	608	762	540	240	612	135	Patras & Zante, 53
CERIGO ..	2701	2658	2431	2525	1381	960	410	380	381	748	417	558	581	368	740	280	191	CERIGO
Piræus ..	2810	2767	2540	2634	1490	1068	520	488	489	856	358	599	689	476	848	388	300	108	Piræus & Nauplia, 96
Salonica ..	3017	2973	2746	2840	1696	1275	724	695	696	1063	339	745	896	683	1055	595	506	315	257	Salonica
Gallipoli ..	3003	2959	2732	2826	1682	1261	711	681	682	1049	115	680	882	669	1041	581	492	301	243	224	Gallipoli
Danube ..	3373	3330	3103	3197	2053	1632	1082	1052	1053	1420	256	1051	1253	1040	1412	952	863	672	614	595	371	Danube
Odessa ..	3458	3414	3187	3281	2137	1716	1166	1136	1137	1504	340	1135	1337	1124	1496	1036	947	756	698	679	455	94	Odessa
Sebastopol ..	3408	3364	3137	3231	2087	1666	1116	1086	1087	1454	290	1085	1287	1074	1446	986	897	706	648	629	405	163	163	Sebastopol
Smyrna ..	2966	2923	2696	2790	1646	1225	675	645	646	1013	283	628	846	633	1005	545	456	265	207	258	168	539	623	573	Smyrna & Nauplia, 260
Rhodes ..	2954	2911	2684	2778	1634	1223	663	643	634	1011	445	368	834	631	1003	543	454	263	253	390	330	701	785	735	2[illegible]4	Rhodes
Famagousta ..	3276	3232	3005	3099	1955	1541	984	901	955	1332	781	250	1155	952	1324	861	775	571	589	726	666	1037	1121	1071	580	336	Famagousta
Tripoli ..	2343	3300	3073	3167	2023	1609	1052	1029	1023	1400	845	265	1223	1020	1390	930	843	639	653	790	730	1101	1185	1135	644	400	100	Tripoli
Beirut ..	3339	3296	3069	3163	2019	1595	1040	1015	1018	13[illegible]6	834	227	1219	1008	1378	907	829	627	641	779	719	1090	1174	1124	633	389	105	42	Beirut & Haifa, 70
Jaffa ..	3327	3284	3057	3151	2007	1590	1029	1016	1007	1387	859	133	1208	1009	1379	908	830	626	607	804	744	1115	1199	1149	658	414	189	161	120	Jaffa & Haifa, 58
Alexandria ..	3114	3071	2844	3938	1794	1398	820	818	800	1206	739	146	994	830	1200	727	650	465	511	672	624	995	1079	1029	540	326	328	3[illegible]4	333	261	Alexandria
Ras al Hillil	2720	2677	2450	2544	1400	1036	418	456	414	890	616	525	600	510	882	422	348	197	312	515	501	869	953	906	465	382	610	684	666	636	402	Ras al Hillil
Tripoli ..	2392	2349	2122	2216	1072	710	198	347	247	937	947	987	272	557	929	544	537	524	636	846	832	1203	1287	1237	790	801	1062	1135	1112	1088	854	452	Tripoli
Sfax ..	2329	2286	2059	2153	1009	677	223	362	262	950	1034	1121	209	570	942	579	578	617	717	932	918	1289	1373	1323	882	871	1176	1243	1228	1211	988	586	166	Sfax

PORT SAID AND PORTS IN THE EASTERN HEMISPHERE.

Aden	Karachi	Bombay	Colombo	Galle	Madras	Calcutta	Maulmain	Batavia	Singapore	Diego Garcia	Seychelles	Mauritius	Zanzibar	Natal	Algoa Bay	Cape	Manila
1395	2832	3032	3495	3529	4054	4709	4721	5287	5026	3480	2793	3730	3108	4557	4936	5313	6349

Hongkong	Shanghai	Nagasaki	Yokohama	Freemantle	Adelaide	Melbourne	Hobart	Sydney	Brisbane	Auckland	Wellington
6465	7209	7442	7928	6320	7530	7835	7986	8299	8698	9395	[illegible]

CORINTH CANAL AND

Venice	Brindisi	Messina	Piræus	Smyrna	Constantinople
686	305	378	36	233	384

THE NAVIGABLE DISTANCES IN NAUTICAL MILES BETWEEN PORTS IN THE BRITISH ISLES AND NORTH SEA, BALTIC AND NORWEGIAN PORTS.

Ports	Gravesend	Harwich	Hull	Newcastle	Leith	Aberdeen	Dover*	Antwerp	Rotterdam	Amsterdam	Wilhelmshaven	Hamburg	Brunsbuttel	The Skaw	Gothenburg	Copenhagen	Kiel	Swinemunde	Danzig	Memel	Riga	Revel	Helsingfors	Kronstadt	Stockholm	Carlscrona	Christiania	Christiansand	Skudenes	Odde	Bergen	Molde	Trondhjem	Tromso	Hammerfest	North Cape	Arkhangel
Dover	67	63	210	283	390	404																															
Antwerp	170	140	250	325	422	440	134																														
Rotterdam	164	127	210	287	390	395	137	113																													
Amsterdam	185	140	210	[illegible]	369	380	160	140	69																												
Wilhelmshaven	340	297	315	358	432	415	381	315	245	210																											
Hamburg	411	372	386	425	498	476	400	391	320	287	123																										
Brunsbuttel	366	325	339	378	451	429	353	344	273	240	76	47																									
The Skaw	537	487	455	433	468	413	525	523	452	418	327	367	278																								
Gothenburg	582	532	500	478	513	458	570	568	497	463	372	412	282	45																							
Copenhagen	682	632	600	578	613	558	670	668	597	563	472	512	211	145	138																						
Kiel	761	711	679	657	692	637	749	747	676	642	551	591	54	224	228	157																					
Swinemunde	808	758	726	704	730	684	796	794	723	689	598	638	234	271	264	126	180																				
Danzig	947	897	865	843	878	823	935	933	862	828	737	772	385	405	403	265	331	195																			
Memel	992	942	910	888	923	868	980	978	968	873	782	822	454	455	448	310	400	260	117																		
Riga	1147	1097	1065	1043	1078	1023	1135	1133	1062	1028	937	977	599	610	603	465	545	443	325	236																	
Revel	1194	1144	1112	1090	1125	1070	1182	1180	1110	1075	984	1024	651	657	650	512	597	495	395	298	275																
Helsingfors	1225	1175	1143	1121	1156	1101	1113	1211	1140	1106	1015	1055	676	688	681	543	622	514	412	324	306	45															
Kronstadt	1354	1304	1272	1250	1285	1230	1342	1340	1270	1235	1144	1184	811	817	810	672	757	655	555	458	435	170	150														
Stockholm	1102	1052	1020	998	1033	978	1090	1088	1017	983	892	932	552	565	558	420	498	403	[illegible]	264	271	220	240	378													
Carlscrona	827	777	745	723	758	703	815	813	742	708	617	657	284	290	274	145	230	145	161	193	334	380	401	540	285												
Christiania	656	589	558	520	540	481	625	620	543	506	420	468	421	130	157	268	354	394	533	578	733	780	811	940	688	413											
Christiansand	506	447	408	370	390	336	490	490	412	380	288	335	288	90	135	235	314	361	500	545	700	747	778	907	655	380	158										
Skudenes	510	472	400	335	333	262	505	510	453	418	356	405	358	215	260	360	439	486	625	670	825	872	903	1032	780	505	285	140									
Odde	631	593	521	456	454	383	626	631	574	530	477	526	479	336	381	481	560	607	746	791	946	993	1024	1153	901	626	406	261	121								
Bergen	590	552	470	395	380	305	585	590	533	408	436	485	438	295	340	440	519	566	705	750	905	952	983	1112	860	585	365	220	80	120							
Molde	770	732	640	546	530	448	767	772	717	685	626	677	630	490	535	635	714	701	900	945	1100	1147	1180	1307	1055	780	560	415	275	325	205						
Trondhjem	885	847	755	661	645	560	882	885	834	800	741	792	745	605	650	750	829	876	1015	1060	1215	1262	1293	1422	1170	895	675	530	390	440	320	144					
Tromso	1275	1237	1145	1051	1035	953	1272	1275	1224	1190	1131	1182	1135	995	1040	1140	1219	1266	1405	1450	1605	1652	1683	1812	1560	1285	1065	920	780	830	710	535	480				
Hammerfest	1395	1357	1265	1171	1155	1073	1392	1395	1344	1310	1251	1202	1255	1115	1160	1260	1339	1386	1525	1570	1725	1772	1803	1932	1680	1405	1185	1040	900	950	830	655	600	120			
North Cape	1455	1417	1325	1231	1215	1133	1452	1455	1404	1370	1311	1362	1315	1175	1220	1320	1399	1446	1585	1630	1785	[illegible]	1863	1992	1740	1465	1245	1100	960	1010	890	715	660	180	60		
Arkhangel	2082	2044	1952	1858	1842	1760	2079	2082	2031	1997	1938	1989	1942	1802	1847	1947	2026	2073	2212	2257	2412	2459	2490	2619	2367	2092	1872	1727	1587	1637	1517	1342	1287	807	687	627	

Antwerp to Flushing .. 45
Rotterdam to Pier ends Buoy 18
Cuxhaven to Brunsbuttel .. 16
Stockholm to Sandhamn .. 37
Kronstadt to St. Petersburg 18

Harwich to Shipwash Lt .. 16
Hull to outer buoy .. 25
Leith to May Island .. 24
Amsterdam to 5fms. buoy .. 15
Wilhelmshaven to Whistle buoy 25
Cuxhaven to Elbe Lt. .. 15

Ports	The Skaw	Christiania	Skudenes	Bergen	Molde	Trondhjem	Tromso	Hammerfest	Vadso	Arkhangel
Kirkwall	436	500	260	277	390	500	880	1000	1233	1687
Lerwick	400	470	210	210	300	420	790	910	1143	1597

	Tuskar	Queenstown	Falmouth	Longships	Ushant	Holyhead	Plymouth	Gib.
Finisterre	576	540	470	460	376	660	496	548

	Gravesend	Harwich	Hull	Shields	Leith	Aberdeen	Kirkwall
Harwich	62						
Hull	214	162					
Shields	291	239	132				
Leith	396	344	233	107			
Aberdeen	411	359	254	132	85		
Kirkwall	525	480	379	259	215	131	
Lerwick	565	520	422	306	276	181	97

Kirkwall and Dover 522
Lerwick and Dover 562

North Cape to Vadso 173

Ports	Dover	Dungeness	Spithead	Southampton	Havre	Casquets	Portland Bill	Start	Ushant	Plymouth	Falmouth	Lizard	Longships	Cardiff	Pembroke	Queenstown	Dublin	Liverpool	Belfast	Glasgow
Dungeness	18																			
Spithead	103	85																		
Southampton	119	99	14																	
Havre	113	97	90	104																
Casquets	166	148	85	86	101															
Portland Bill	154	136	55	56	116	48														
Start	201	183	104	105	151	57	48													
Ushant	299	281	219	216	234	133	162	121												
Plymouth	227	209	130	131	178	78	74	26	120											
Falmouth	255	237	158	159	202	105	102	54	102	37										
Lizard	263	244	166	167	208	113	110	62	90	47	15									
Longships	287	268	190	191	232	134	134	86	100	71	39	24								
Cardiff	431	412	334	335	376	278	278	230	244	215	183	168	144							
Pembroke	397	378	300	301	342	244	244	196	210	181	149	134	110	96						
Queenstown	428	409	331	332	373	275	275	227	235	212	180	165	141	202	125					
Dublin	494	475	397	398	439	341	341	293	307	279	246	231	207	202	125	160				
Liverpool	560	541	463	464	505	407	407	359	373	344	312	297	273	268	193	241	120			
Belfast	584	565	487	488	529	431	431	383	397	368	336	321	297	292	216	253	107	140		
Glasgow	667	648	[illegible]	[illegible]	[illegible]	514	514	466	480	451	419	404	380	375	300	340	195	220	115	

BY NORTHERN ROUTE.

Ports	Instrahull	Cape Wrath	Newcastle	Leith	Aberdeen	The Skaw	Skudenes	Christiansand	Christiania	Bergen	Trondhjem	Tromso
Glasgow	133	321	618	574	492	819	641	743	884	667	879	1247
Belfast	87	284	581	537	455	782	604	706	847	630	842	1210
Liverpool	202	395	692	648	566	893	715	817	958	741	953	1321
Dublin	170	363	660	616	534	861	683	785	926	709	921	1289
C. Wrath	215		297	253	171	498	320	422	563	346	558	826

* In the preceding Tables the distances to Dover may be found by taking 90 m. from the London distances.

Gravesend to London 23
" to Ushant 356

Holyhead to Tuskar 87

BY KAISER WILHELM CANAL.

Ports	Dover	Gravesend	Harwich	Hull	Newcastle	Leith	Aberdeen	Antwerp	Rotterdam	Amsterdam	Wilhelmshaven	Hamburg
Kiel	405	420	380	393	432	505	483	398	327	294	130	101
Swinemunde	585	600	560	573	612	685	663	578	507	474	310	281
Danzig	736	751	711	724	763	836	814	729	658	625	461	432
Memel	805	820	760	793	832	905	883	798	727	691	530	501
Riga	950	965	925	938	977	1050	1028	943	872	839	675	646
Revel	1002	1017	977	990	1029	1102	1080	995	924	891	727	698
Kronstadt	1162	1177	1137	1150	1189	1262	1240	1155	1084	1051	887	858
Helsingfors	1027	1042	1002	1015	1054	1127	1105	1120	949	916	752	723
Stockholm	903	918	878	891	930	1003	981	896	825	792	628	599
Carlscrona	635	650	610	623	662	735	713	628	557	524	360	331
Copenhagen	562	577	537	550	589	662	640	555	484	451	287	258

	Glasgow	Liverpool	Belfast	Dublin	Cardiff	Queenstown	Longships	Bishop	Cape Verde	Cape Frio
Holyhead	188	70	106	59	192	171	204	220	2409	4991
Tuskar	259	158	172	85	133	81	130	140	2325	4965

AVERAGE NAVIGABLE DISTANCES IN NAUTICAL MILES BETWEEN GRAVESEND, PORT SAID, THE CAPE, AND PORTS IN THE PACIFIC OCEAN; ON THE TRACKS FOLLOWED BY SAILING SHIPS AND VESSELS WITH AUXILIARY STEAM POWER.

						VIA CAPE OF GOOD HOPE.*														VIA CAPE HORN.													
Gravesend	Gravesend v. S. Canal	Hamburg	Hamburg v. S. Canal	Cape of Good Hope	Port Said	Petropaulski	Yokohama	Shanghai	Hongkong	Singapore	Manila	Batavia	Cape York	Brisbane	Auckland	Sydney	Wellington	Melbourne	Hobart	Esquimalt	San Francisco	Mazatlan	Panama	Guayaquil	Callao	Valparaiso	Sandy Point	Cape Horn	Honolulu	Nukahiva	Tahiti	Levuka	PORTS
	—	411	—	7446	3217	17327	15985	15293	14627	13329	14357	12877	15037	13977	14515	13499	14265	13059	13057	14980	14730	14380	11477	10843	10192	8958	7356	7380	13978	11894	11814	14107	Gravesend
—		—	—		—	12487	11145	10426	9683	8213	9506	8504	10664	11904	12612	11516	12407	11032	11203	15385	15615	16835	18745	18697	18253	17557	16590	16660	14925	15937	15137	12832	Do. v. S. Can.
411	—		—	7779	3550	17660	16318	15626	14960	13662	14690	13210	15370	14310	14848	13832	14498	13392	13390	15313	15063	14713	11810	11176	10525	9291	7689	7713	14311	12227	12147	14140	Hamburg
—	—	—		8863	—	12820	11478	10759	10016	8576	9899	8837	10997	12237	12945	11849	12740	11385	11536	15718	15948	17168	19078	19030	18586	17890	16923	16993	15258	16270	15470	13165	Do. v. S. Can.
7423	8530	7736	8863		5314	10029	8687	7995	7329	6031	7059	5579	7739	6680	7220	6200	6970	5761	5760	12857	13087	14307	13880	13242	12816	12120	10170	10240	12467	10500	9700	7925	C. of G. Hope
3217	—	3550	—	5314		9270	7928	7209	6465	5026	6349	5287	7446	8692	9395	8299	9185	7835	7986	12100	12328	13548	15528	15462	15036	14340	13373	13443	11638	12666	11915	10 04	Port Said
18314	12487	18647	12820	10891	9270		1402	2232	2900	6020	5370	5720	4460	5050	5710	5270	6027	5876	5925	2840	3300	4550	6460	6910	10533	9988	9728	9795	2820	5230	5220	4600	Petropaulski
17309	11145	17642	11478	9886	7928	1402		1068	1602	5015	4340	4715	3520	4680	5210	5020	5472	5596	5645	4240	4470	5690	7600	8050	11080	10543	10008	10078	3780	6310	6180	4545	Yokohama
18062	10426	18395	10759	10639	7200	2220	1068		824	5768	5100	5468	4258	5530	6055	5900	6300	6476	6525	5100	5470	6690	8600	9050	12086	11543	11006	11076	4780	7310	7180	5543	Shanghai
14394	9683	14077	10016	6972	6465	2900	1602	824		1930	650	2313	2700	6070	7187	6440	7504	7016	7065	5766	6000	7220	9130	9580	12626	12077	11540	11610	5312	7840	7710	6077	Hongkong
13090	8243	13379	8576	5073	5026	4244	2902	2183	1440		1323	509	2500	5730	6360	5250	6146	4800	4887	7072	7302	8522	10430	10882	11649	10826	10244	10311	6612	9212	9082	6975	Singapore
14125	9566	14407	9899	6702	6349	3110	1768	1130	650	1323		1583	2175	4190	4720	4560	4960	5136	5185	5938	6168	7388	9300	9748	12199	11372	10754	10821	5478	8078	7948	7485	Manila
12645	8504	12927	8837	5222	5287	4506	3164	2472	1813	509	1583		2160	5375	5981	4882	5776	4426	4523	7334	7564	8784	10700	11144	11289	10462	9634	97[illegible]1	6874	9474	9344	6460	Batavia
14523	10664	15087	10997	7100	7446	4790	3465	3180	2767	2450	2220	2160		1246	2415	1695	2512	2271	2320	7635	7865	8985	9414	8784	8358	7662	7074	7141	7175	6042	5242	2820	Cape York
14278	11904	14611	12237	7718	8692	4835	3915	4230	4013	3696	3466	3406	1288		1342	480	1413	1056	1105	7970	8200	8213	8284	7654	7229	6533	5928	5995	6513	4913	4113	1583	Brisbane
13098	12612	13431	12945	8336	9861	5455	4800	5164	5182	4865	4635	4575	2415	1342		1289	543	1675	1510	7940	7640	6600	6959	6329	5904	5333	4745	4815	5360	3300	2960	1162	Auckland
14065	11516	14398	11849	7238	8299	5264	4380	4700	4462	4145	3915	3865	1695	480	1289		1231	576	625	8390	8628	8030	8102	7472	7046	6300	5712	5782	6330	4730	3930	1786	Sydney
12012	12407	13245	12740	8132	9958	5720	5025	5364	5274	4957	4727	4672	2512	1413	543	1231		1489	1287	7710	7410	6830	6902	6272	5846	5150	4559	4629	5130	3530	2730	1487	Wellington
14121	11052	14454	11385	6777	7835	5840	4956	5276	5038	4721	4491	4431	2271	1056	1675	576	1489		490	9180	8880	8300	8220	7590	7164	6392	5771	5838	6600	5000	4200	2289	Melbourne
13723	11203	14056	11536	6928	7986	5889	5025	5325	5087	4770	4540	4180	2320	1105	1510	625	1287	490		8900	8600	7960	7914	7374	6858	5960	5372	5440	6320	4660	3900	2248	Hobart
16241	16497	10574	16829	12055	13018	5850	6000	6816	7250	8253	7153	8323	6513	6420	6121	6764	6360	7310	7293		740	2066	3968	4418	7810	8085	7888	7958	2343	3603	4234	5063	Esquimalt
15501	16239	15834	10572	11315	13353	5536	5686	6502	6936	7996	6896	8066	6256	6156	5676	6463	5890	6995	6990	740		1341	3243	3693	7070	7318	7148	7218	2086	2971	3652	4703	San Franc.
14531	16994	14864	17327	10345	141[illegible]	6291	6441	7257	7710	8751	7650	8820	6950	6544	5739	6780	5853	7185	7105	3160	2910		1983	2433	6224	6348	6180	6248	2841	2762	3513	5025	Mazatlan
14103	10423	14430	19756	9917	16467	8650	8800	9616	10140	11180	9980	10840	8620	8050	6811	7928	6930	8332	8185	5710	5460	5180		821	5580	5214	5700	5820	5200	3940	4590	6410	Panama
12431	10033	12764	19366	8245	157[illegible]6	8314	8464	9356	9880	10740	9720	10450	8290	7488	6455	7672	6574	7976	7830	5450	5200	4920	821		1140	3672	4008	4148	4864	3655	4234	6081	Guayaquil
11503	10033	11896	19366	7447	15661	8610	8763	9706	10137	10740	9930	10450	8290	7363	6417	7534	6536	7938	7790	5860	5610	5180	1342	708		2590	3208	3350	5163	3721	4196	6036	Callao
10063	18833	10396	19165	5877	15629	9392	9326	10266	10521	10624	10068	10330	8170	7526	6529	7638	6648	8050	7903	6730	6480	6120	2622	1988	1295		1616	1780	5942	4063	4308	60[illegible]3	Valparaiso
8353	19225	8686	19558	4167	16008	9880	9715	10620	10819	11022	10440	10732	8561	7917	6900	8017	6983	8421	8279	7436	7208	6856	3953	3319	2648	1414		403	6430	4438	4679	6600	Sandy Point
8283	10367	8616	19[illegible]00	4097	1615[illegible]	10022	9857	10762	10961	11164	10580	10874	8703	8259	7042	8159	7125	8363	8419	7600	7350	7000	4097	3463	2812	1578	403		6572	4580	4821	6727	Cape Horn
15140	14153	15373	14486	10954	11267	3450	3600	4416	4860	5910	4810	5980	4170	4036	3805	4410	4057	4956	4950	2580	2280	3430	5340	5790	7683	6898	6790	6857		3151	2400	2715	Honolulu
12548	15403	15181	15736	8662	12107	4879	5277	6179	6498	7160	6150	6820	4660	3948	2970	4081	3091	4516	4376	3820	3570	3300	5210	5729	5303	4758	4500	4965	2095		751	2439	Nukahiva
12737	14631	13070	14964	8551	11414	5023	5138	5945	6140	6417	5760	6127	3967	3238	2221	3338	2340	3742	3595	4571	4321	4051	6099	5469	5283	4498	4387	4454	2400	751		1902	Tahiti
13861	12843	14149	13176	8537	9625	4365	3891	4457	4491	4629	4080	4339	2179	1583	1162	1786	1487	2289	2248	5560	5550	5750	7600	6969	6543	6000	5511	5578	4440	3700	2800		Levuka

These Distances have necessarily been measured both ways; *e.g.* the Distance for a Sailing Ship, Vessel with only Auxiliary Steam Power, from Valparaiso to Callao is 1295 miles, but from Callao to Valparaiso the Distance is 2590 miles. Similarly the Distance from San Francisco to Manila is [illegible] miles, but from Manila to San Francisco it is 6168 miles.

Take 88 miles from Gravesend Distances to find Liverpool Distances.

Add 100 miles to Gravesend Distances to find Glasgow Distances.

Take 67 miles from Gravesend Distances to find Dover Distances, and so connect with Baltic and North Sea ports. *See* p. 643A. Port Said is connected with European ports. *See* p. 643.

* Calling at Cape Town adds about 200 miles to these distances.

If bound to Atlantic ports of the U.S. or Halifax *from* the Pacific, add 7500 miles to the Cape Horn, and 6800 miles to the Cape of Good Hope Distances. If bound *to* the Pacific, add 7800 miles to the Cape Horn, and 7700 miles to the Cape of Good Hope Distances.

TIME SIGNALS, 1902*

It will be noticed that many countries have now adopted a uniform time system.

Great Britain, Belgium, Netherlands, Spain, and Portugal have adopted Greenwich mean time as a standard.

In Ireland the mean time of the Observatory at Dublin is the standard, 25^{m} 22^{s} slow of G.M.T.

Austria-Hungary, Denmark, Germany, Italy, Norway and Sweden, and the British Colony of Malta have adopted the Meridian of 15° E. from Greenwich as a standard, or 1 hour fast of G.M.T. This is known as Mid European time. France and Algeria use the Meridian of Paris, 9^{m} 21^{s} fast of G.M.T.

Cape Colony has adopted the Meridian of 22½° E. as a standard, or 1½ hours fast of G.M.T. This is known as Cape Colony mean time. Egypt and Natal have adopted Meridian of 30° E., or 2^{h} fast of G.M.T.

Japan has adopted as a standard the Meridian of 135° East from Greenwich, or 9 hours fast of G.M.T. This is known as Japan mean time. Straits Settlements, Mer. of Ft. Fullerton, Singapore, 6^{h} 55^{m} 25^{s} fast of G.M.T.

In the Colony of West Australia and Phillipine Islands, the standard time of the Meridian of 120° E. of Greenwich, or 8 hours fast of G.M.T., has been established.

In the Colony of South Australia the standard time of the Meridian of 142° 30′ E. of Greenwich, or 9 hours 30 min. fast of G.M.T., has been established.

In the Colonies of Queensland, New South Wales, Victoria, and Tasmania the standard time of the Meridian of 150° E., or 10 hours fast of G.M.T. has been established.

New Zealand has adopted as a standard the Meridian of 172½° E. from Greenwich, or 11½ hours fast of G.M.T. This is known as New Zealand mean time.

In the United States of America, at the Atlantic ports and Cuba, the standard time of the Meridian of 75° W. of Greenwich, or 5 hours slow of G.M.T. has been established. At Pacific ports and British Columbia the standard time is that of the Meridian of 120° W., or 8 hours slow of G.M.T.*

Lat.	Long.	Place	Signal adopted	Situation of Time Signal	Time of Signal being made		Greenwich Time of Preparatory Signal
					Greenwich Mean Time	Local Mean Time	
° ′ ″	° ′ ″				h m s	h m s	h m s
51 28 39 N.	0 0 0	Greenwich .	Ball	Royal Observatory .	1 00 00	1 00 00	12 55 00 and 12 57 30
51 26 45 N.	0 44 45 E.	Sheerness .	Ball	Garrison Flagstaff .	1 00 00	1 2 59	—
51 13 17 N.	1 24 22 E.	Deal . .	Ball	Telegraph Tower .	1 00 00	1 05 37	12 55 00 and 12 57 00
51 7 15 N.	1 19 40 E.	Dover . .	Gun	Drop Battery . .	0 00 00	0 05 19	—
50 48 0 N.	1 6 18 W.	Portsmouth .	Ball	Dock Yd. Semaphore	1 00 00	0 55 35	12 55 00
50 8 45 N.	5 2 45 W.	Falmouth .	Ball	Pendennis Castle .	1 00 00	0 39 49	—
50 53 39 N.	1 24 5 W.	Southampton	Ball	South Castle . .	1 00 00	0 54 24	12 55 00
50 22 0 N.	4 10 20 W.	Devonport .	Ball	Mount Wise . .	1 00 00	0 43 19	12 55 00
—	—	"	Gun	" . .	1 00 00	0 43 19	—
51 36 55 N.	3 55 35 W.	Swansea .	Gun	On old Eastern Pier	1 00 00	0 44 18	—
53 24 4 N.	3 0 36 W.	Liverpool .	Gun	Birkenhead, Murpeth Dock	1 00 00	0 47 58	—
56 27 56 N.	2 58 45 W.	Dundee. .	Gun	—	1 00 00	0 48 05	—
55 57 23 N.	3 10 54 W.	Edinburgh .	Ball	Nelson's Monument.	1 00 00	0 47 16	12 55 00 and 12 57 00
—	—	"	Gun	Edinburgh Castle .	1 00 00	0 47 16	—
55 0 32 N.	1 27 28 W.	North Shields	Gun	Near Albert Edward Dock	1 00 00	0 54 10	—
51 53 53 N.	8 27 17 W.	Cork . .	Gun	Victoria Quay . .	1 00 00	0 26 11	—
51 51 9 N.	8 16 37 W.	Queenstown .	Gun	Near Military Hosp.	1 00 00	0 26 53	—
53 20 46 N.	6 15 30 W.	Dublin . .	Ball	Docks Board Building	1 00 00	0 34 58	—
24 49 11 N.	66 58 00 E.	Karachi .	Ball	Merewether Pier .	20 32 8	1 00 00	20 27 8
18 55 51 N.	72 50 33 E.	Bombay† .	Ball	Bombay Castle .	20 08 44	1 00 00	20 03 44
18 57 13 N.	72 50 46 E.	"	Ball	Clock Tower, Docks	15 00 00	7 51 16	14 55 00
6 56 34 N.	79 50 34 E.	Colombo .	Sema.	Master Attendant's .	22 54 1	4 15 00‡	22 49 1
16 46 0 N.	96 10 0 E.	Rangoon .	Ball	Sailors' Home . .	17 35 20	0 00 00	17 30 20
13 5 47 N.	80 17 37 E.	Madras . .	Semaphore	Master Attendant's Office	19 39 00	1 00 00	—
22 33 25 N.	88 20 12 E.	Calcutta .	Ball	Fort William . .	19 06 39	1 00 00	19 01 39
—	—	"	Ball	Port Commissioner's	19 06 39	1 00 00	19 01 39
22 17 44 N.	114 10 8 E.	Hongkong .	Ball	Kau'ung Tower .	17 23 18	1 00 00	17 18 18
1 17 33 N.	103 50 53 E.	Singapore .	Ball	Ft. Canning Flagstaff	18 4 35	1 00 00	18 00 00
1 15 45 N	103 50 00 E.	"	Ball	Pulo Brani . .	18 4 35	1 00 00	18 00 00
6 5 48 S.	106 53 07 E.	Batavia. .	Discs	Tanjong Priok Basin	16 52 28	0 00 00	16 47 28
—	—	"	Discs	"	18 00 00	1 07 32	17 55 00
7 12 10 S.	112 43 40 E.	Sourabaya .	Discs	Kalimas River .	16 29 05	0 00 00	16 24 05
15 55 0 S.	5 42 30 W.	St. Helena .	Ball	Ladder Hill Flagstaff	1 00 00	0 37 10	12 55 00
—	—	"	Ball	Time Office . .	1 00 00	0 37 10	12 55 00
5 31 48 N.	0 11 30 W.	Accra . .	Flag	Telegraph Office .	11 00 46	11 00 00	—
8 48 45 S.	13 13 20 E.	Paul de Loanda	Ball	Observatory . .	0 7 7	1 00 00	0 2 7

* For more detailed and later information on Time Signals *see* Admiralty List of Time Signals, sold by J. D. Potter, Agent for Admiralty Charts, 145 Minories, E.

† Clock on N.E. Bastion shows Bombay mean time.

‡ Madras mean time, also at 8^{h} 15^{m} a.m.

TIME SIGNALS, 1902

Lat.	Long.	Place	Signal adopted	Situation of Time Signal	Time of Signal being made: Greenwich Mean Time	Time of Signal being made: Local Mean Time	Greenwich Time of Preparatory Signal
° ′ ″	° ′ ″				h m s	h m s	h m s
33 54 24 S.	18 25 15 E.	Table Bay * .	Ball	At Alfred Docks .	0 00 00	1 30 00	—
—	—	"	Gun	On Imhoff Battery .	0 00 00	1 30 00	—
34 11 35 S.	18 25 58 E.	Simons Bay .	Disc	Telegraph Office .	0 00 00	1 30 00	23 55 00
33 57 43 S.	25 37 19 E.	Port Elizabeth	Ball	At the Lighthouse .	0 00 00	1 30 00	—
33 36 10 S.	26 54 5 E.	Port Alfred .	Ball	—	0 00 00	1 30 00	—
33 1 50 S.	27 34 55 E.	East London	Ball	Signal Hill . .	0 00 00	1 30 00	—
29 52 30 S.	31 3 0 E.	Natal . .	Ball	North Entrance Point	22 55 59	0 25 59	—
20 10 5 S.	57 29 0 E.	Mauritius .	Ball	Signal Mt. Pt. Louis	21 09 47	1 00 00	21 04 47
32 3 12 S.	115 44 15 E.	Fremantle .	Ball	Arthur Head . .	17 0 0	0 42 57	16 57 00
34 51 6 S.	138 28 50 E.	Adelaide† .	Ball	At the Semaphore .	15 30 00	0 43 55	15 25 00
37 52 7 S.	144 54 47 E.	Port Phillip .	Ball	Gellibrand Point .	15 00 00	0 39 39	14 55 00
38 9 00 S.	144 21 00 E.	—	Ball	Telegraph, Geelong .	15 00 00	0 37 24	14 55 00
38 16 27 S.	144 39 45 E.	—	Flag	Queenscliff Signals .	15 00 00	0 38 39	—
33 51 41 S.	151 12 23 E.	Sydney .	Ball	Observatory . .	15 00 00	1 04 49	14 55 00
32 55 43 S.	151 47 28 E.	Newcastle .	Ball	Custom House .	15 00 00	1 07 10	14 55 00
27 28 3 S.	153 1 31 E.	Brisbane .	Ball	Signal Tower .	15 00 00	1 12 06	14 55 00
42 53 22 S	147 20 28 E.	Hobart . .	Ball	Fort Mulgrave .	15 00 00	0 49 20	14 50 00
—	—	"	Gun	Queen's Battery .	—	—	—
43 36 42 S.	172 44 50 E.	Lyttelton .	Ball	Observatory . .	13 30 00	1 00 59	13 25 00
41 16 50 S.	174 46 55 E.	Wellington .	Ball	Railway Wharf‡ .	12 30 00	0 09 08	—
45 49 0 S.	170 39 0 E.	Otago . .	Ball	Signal Staff, Port	12 30 00	11 52 36	Once a week
36 50 44 S.	174 45 52 E.	Auckland .	Ball	Post Office Flagstaff	12 30 00	0 09 03	12 25 00
47 34 10 N	52 40 27 W.	St. John's .	Gun	Signal Hill . .	3 30 43 ?	0 00 00	—
45 15 42 N.	66 3 45 W	St. John, N.B.	Ball	New Custom House	5 00 00	1 00 00	4 45 00
46 48 23 N.	71 12 17 W.	Quebec . .	Ball	At Citadel . .	6 00 00	1 15 11	5 55 00
45 31 0 N.	73 33 15 W.	Montreal .	Ball	Harbour Office .	5 00 00	0 5 47	4 55 00
32 19 22 N.	64 49 35 W.	Bermuda § .	Ball	Dockyard Flagstaff	4 19 18	0 00 00	4 14 18
23 08 30 N.	82 20 50 W.	Havana .	Ball	Naval Office . .	5 00 00	11 30 36	4 50 00
14 00 53 N.	61 00 00 W.	St. Lucia .	Ball	Harbour Master's Office, Castries	4 04 00	0 00 00	3 59 00
6 48 48 N.	58 9 52 W.	Demerara .	Ball	General Post Office .	3 52 39	0 00 00	3 47 46
10 39 0 N.	61 30 38 W.	Trinidad .	Ball	Observatory Tower	4 06 02 ?	0 00 00	—
5 49 30 N	55 8 48 W.	Paramaribo .	Disc	Guardship . .	3 40 35	0 00 00	3 35 35
12 6 45 N.	68 56 44 W.	Curaçao .	Flag	Guardship . .	4 35 47	0 00 00	4 30 47
22 54 24 S.	43 10 21 W.	Rio de Janeiro	Drum	Mount Castello .	2 52 41	0 00 00	2 47 41
34 52 33 S.	57 54 43 W.	Rio de la Plata	Ball	Dock Engine Ho. .	2 51 39 ?	23 00 00	2 47 39
34 35 50 S.	58 22 15 W.	Buenos Aires	Ball	Hyd. Office . .	5 16 48	1 23 19	5 14 48
51 13 15 N.	4 24 15 E.	Antwerp .	Discs	Hanseatic House .	1 00 00	1 17 37	12 55 00
51 26 33 N.	3 35 48 E.	Flushing .	Discs	Stone Tower of sluice	23 45 37	0 00 00	23 40 37
51 49 19 N.	4 7 40 E.	Hellevoetsluis	Discs	Marine Establishment	23 43 29	0 00 00	23 38 29
52 22 40 N.	4 54 45 E.	Amsterdam .	Discs	Commercial Quay .	23 40 21	0 00 00	23 35 21
51 54 39 N.	4 29 47 E.	Rotterdam .	Discs	Gate Building .	23 42 01	0 00 00	13 37 01
52 57 50 N.	4 46 36 E.	Willemsoord	Discs	Marine Office . .	23 40 54	0 00 00	23 35 54
53 31 54 N.	8 8 48 E.	Wilhelmshaven¶	Ball	Observatory . .	23 00 00	11 32 35	20 50 00
—	—		Ball	"	0 00 00	0 32 35	23 57 00
53 32 51 N.	8 34 7 E.	Bremerhaven	Ball	S.W. of Lighthouse	23 00 00	11 34 16	22 50 00
—	—	"	Ball	"	0 00 00	0 34 16	23 57 00
53 52 24 N.	8 42 30 E.	Cuxhaven .	Ball	E. of Lighthouse .	23 00 00	11 34 50	22 50 00
—	—	"	Ball	"	0 00 00	0 34 50	23 57 00
53 32 30 N.	9 58 57 E.	Hamburg .	Ball	On the Kaiser Quay	0 00 00	0 39 56	23 50 00
54 19 18 N.	10 9 40 E.	Kiel . .	Ball	Imperial Wharf .	23 00 00	11 40 39	22 50 00
—	—	"	Gun	Guardship . .	23 00 00	11 40 39	—
53 54 36 N.	14 15 58 E.	Swinemunde .	Ball	S.W. of Lighthouse	22 00 00	10 57 4	21 50 00
—	—	"	Ball	"	3 00 00	3 57 4	2 50 00
54 24 18 N.	18 40 10 E.	Neufahrwasser	Ball	Lighthouse . .	23 00 00	1 14 41	22 50 00
56 2 4 N.	12 37 24 E.	Elsinore .	Ball	Quarantine House .	0 00 00	0 50 30	23 55 00
57 42 34 N.	11 58 0 E.	Gothenburg .	Ball	Navigation School .	0 00 00	0 47 52	23 55 00
55 40 42 N.	12 35 7 E.	Copenhagen .	Ball	Nikolai Tower . .	0 00 00	0 50 19	23 55 00
55 37 0 N.	13 0 15 E	Malmo . .	Ball	School of Navigation	0 00 00	0 52 02	23 55 00
56 09 28 N.	15 35 36 E.	Carlskrona .	Ball	Dockyard Tower .	0 00 00	1 [illegible] 23	23 54 00
59 19 10 N.	18 4 44 E.	Stockholm .	Ball	School of Navigation	0 00 00	1 12 19	23 55 00

* Cape Colony mean time.
† Balls dropped at $1^h\ 00^m\ 00^s$, standard times, of the Australian Colonies and New Zealand.
‡ Once a week. § On Saturdays only. ‖ At Demerara, on Wednesday and Saturday only
¶ Balls dropped at $1^h\ 00^m\ 00^s$, Mid-European time, throughout Germany and Denmark.

TIME SIGNALS, 1902

Lat.	Long.	Place	Signal adopted	Situation of Time Signal	Time of Signal being made: Greenwich Mean Time	Time of Signal being made: Local Mean Time	Greenwich Time of Preparatory Signal
° ′ ″	° ′ ″				h m s	h m s	h m s
56 56 52 N.	24 05 30 E.	Riga	Ball	Sailors' Home	23 23 32	0 59 54	23 18 32
59 59 24 N.	29 45 54 E.	Kronstadt	Ball	Marine Telegraph	22 00 56	0 00 00	21 52 56
59 56 31 N.	30 18 22 E.	St. Petersburg	Gun	Fort Petri-Paul	21 58 41	0 00 00	—
60 9 49 N.	24 57 7 E.	Helsingfors	Ball	Observatory	22 20 11	0 00 00	22 16 11
60 26 57 N.	22 17 43 E.	Abo	Ball	Navigating School	22 30 51	0 00 00	22 24 51
65 1 19 N.	25 30 30 E.	Uleaborg	Ball	Navigation School	22 17 58	0 00 00	22 12 58
63 25 40 N.	10 22 4 E.	Trondhjem*	Ball	Observatory	23 00 00	23 41 28	22 45 00
60 23 53 N.	5 18 35 E.	Borgen*	Ball	Observatory	23 00 00	23 21 13	22 45 00
59 45 44 N.	10 43 33 E.	Christiania*	Drum	Observatory	23 00 00	23 42 54	22 55 00
49 38 42 N.	1 37 34 W.	Cherbourg	Disc	Marine Observatory	21 50 39	10 00 00†	21 45 39
48 22 46 N.	4 29 48 W.	Brest	Flag	Observatory	21 50 39	10 00 00†	21 45 39
47 44 45 N.	3 21 15 W.	L'Orient	Ball	Harbour Tower	21 50 39	10 00 00†	21 45 39
45 59 10 N.	1 5 50 W.	F u as	Balloon	Tower	21 50 39	10 00 00†	21 45 39
45 56 10 N.	0 57 35 W.	Rochefort	Balloon	St. Louis Tower	21 50 39	10 00 00†	21 45 39
38 42 18 N.	9 8 24 W.	Lisbon	Ball	Naval School	1 36 45	1 00 00	1 31 45
36 27 41 N.	6 12 24 W.	Cadiz	Ball	Observatory	1 24 50	1 00 00	1 14 50
43 7 22 N.	5 55 27 E.	Toulon	Ball	Naval Observatory	21 50 39	10 00 00†	21 40 39
36 47 0 N.	3 3 15 E.	Algier	Clock	Town Hall	Clock shows Paris Mean Time.		
44 25 10 N.	8 55 21 E.	Genoa‡	Gun	Fort Castellaccio	23 00 00	23 35 41	22 55 00
44 6 55 N.	9 49 33 E.	Spezia	Gun	Lagora Mole	23 00 00	23 39 18	—
40 28 20 N.	17 14 10 E.	Taranto	Ball	St. Angelo Castle	23 00 00	0 8 57	22 55 00
44 52 8 N.	13 50 45 E.	Pola	Ball	Harbour Castle	23 00 00	23 55 23	22 55 00
45 38 56 N.	13 45 30 E.	Trieste	Ball	Lighthouse	23 00 00	23 55 02	22 55 00
45 19 36 N.	14 25 44 E.	Fiume	Ball	Staff, Mole end	23 00 00	23 57 43	22 55 00
44 31 49 N.	14 28 6 E.	Lussin Piccolo	Discs	S.W. Quay	23 00 00	23 57 52	—
35 53 50 N.	14 30 55 E.	Malta	Ball	Palace Valetta	23 00 00	23 58 4	22 55 00
			Ball	Custom House	23 00 00	23 58 4	22 55 00
40 50 5 N.	14 15 30 E.	Naples	Ball	Vincenza Mole	23 00 00	23 57 2	22 55 00
31 11 39 N.	29 53 15 E.	Alexandria§	Ball	Fort Napoleon	22 00 00	23 59 33	21 55 00
31 15 45 N.	32 18 45 E.	Port Said ‖	Ball	High Light Ho	22 00 00	0 00 00	21 55 00
46 58 21 N.	31 58 28 E.	Nicolaev (Black Sea)	Ball	Observatory	21 52 06	0 00 00	21 47 6
46 29 0 N.	30 45 0 E.	Odessa	Ball	Russian S.N.Co. Office	21 57 0	0 00 00	21 52 00
41 31 30 N.	70 40 20 W.	Woods Holl ¶	Ball	Water Tower	5 00 00	0 17 19	—
41 29 36 N.	71 19 39 W.	Newport	Ball	Torpedo Station	5 00 00	0 14 41	—
40 43 0 N.	74 0 25 W.	New York	Ball	Union Telegraph Office	5 00 00	0 03 58	4 55 00
39 56 45 N.	75 9 10 W.	Philadelphia	Ball	Maritime Exchange	5 00 00	23 59 23	4 50 00
39 17 51 N.	76 36 57 W.	Baltimore	Ball	Baltimore Railway	5 00 00	23 53 32	—
38 53 39 N.	77 3 8 W.	Washington	Ball	Naval Observatory	5 00 00	23 51 47	4 50 00
37 0 0 N.	76 18 25 W.	Hampton Roads	Ball	Hygeia Hotel	5 00 00	23 54 46	—
32 4 50 N.	81 5 10 W.	Savannah	Ball	Custom House	5 00 00	23 35 39	—
29 57 8 N.	90 3 50 W.	New Orleans	Ball	Sugar House	5 00 00	22 59 43	4 55 00
29 18 0 N.	94 47 30 W.	Galveston	Ball	Levy Building	5 00 00	23 0 0	4 55 00
37 47 40 N.	122 23 35 W.	San Francisco	Ball	Tower of Ferry Ho.**	8 00 00	23 50 23	7 55 00
38 5 53 N.	122 16 16 W.	Mare Island	Ball	The Observatory**	8 00 00	23 50 55	7 55 00
49 17 30 N.	123 7 0 W.	Vancouver	Gun	Brockton Point	17 00 00	9 00 00	—
33 1 50 N.	71 38 30 W.	Valparaiso	Ball	Naval School	4 46 34	0 00 00	4 41 34
21 18 13 N.	157 51 47 W.	Honolulu	Whistle	Steam Mills	12 00 00	1 28 33	—
14 36 0 N.	120 58 0 E.	Manila	Ball	Meteorological Office	16 00 00	0 3 52	15 55 00
20 51 56 N.	106 39 54 E.	Haifong	Ball	Observatory	13 53 20	21 00 00	13 43 20
23 21 43 N.	116 40 30 E.	Swatau	Ball	Harbour Office	16 13 05	0 00 00	—
24 27 25 N.	118 3 33 E.	Amoy	Gun	Kulangseu	16 07 44	0 00 00	16 02 44
31 14 7 N.	121 29 10 E.	Shanghai	Ball	Semaphore	15 54 03	0 00 00	15 49 3
37 33 10 N.	121 25 20 E.	Chifu	Ball	Mast near Tower Hill	15 54 20	1 00 00*	—
34 1 0 N.	135 11 0 E.	Kobe	Ball	On the Bund	15 00 00	0 00 00	—
41 46 35 W.	140 43 50 E.	Hakodate	Flag	Obsy. Fl. staff	15 00 00	0 22 55	14 55 00
43 7 0 N.	131 52 44 E.	Vladivostock	Ball & Gun	Harbour Office	15 12 29	0 00 00	15 07 20

* On Wednesdays and Saturdays. † Paris mean time.
‡ Guns fired and balls dropped at $1^h\ 00^m\ 00^s$ Mid-European time, throughout Norway, Austria, and Italy.
§ Throughout Egypt, the official time kept is standard time of the meridian of 30° E.
‖ Ball at Port Said dropped also at 8^h a.m. and 4^h p.m., standard time.
¶ All time balls on the Atlantic and Gulf of Mexico coasts of the United States are dropped at noon, mean time of the 75th meridian West from Greenwich—equivalent to $5^h\ 00^m\ 00^s$ p.m. Greenwich mean time.
** Balls dropped at noon, mean time of 120th meridian West from Greenwich
N.B.—When the report of the gun is used allow for time of passage of sound. *See* p. 139.

EPACTS											
Years								Months			
Year	Epact	Year	Epact	Year	Epact	Year	Epact	Month	Epact	Month	Epact
	d h		d h		d h		d h		d h		d h
1891	20 9	1897	27 6	1903	2 11	1909	9 4	Jan.	0 0	July	3 20
1892L	1 10	1898	8 8	1904L	13 2	1910	19 19	Feb.	1 11	Aug.	5 7
1893	13 5	1899	19 0	1905	24 17	1911	0 22	March	29 11	Sept.	6 18
1894	24 5	1900	0 2	1906	5 19	1912L	11 13	April	1 10	Oct.	7 5
1895	5 0	1901	10 17	1907	16 11	1913	23 4	May	1 21	Nov.	8 17
1896L	15 15	1902	21 8	1908L	27 2	1914	4 7	June	3 8	Dec.	9 4

TABLE 15.

SEMIMENSTRUAL INEQUALITY OF THE TIME OF HIGH WATER,
For London, Liverpool, Pembroke, Ramsgate, Sheerness, Portsmouth, Plymouth, and Brest.

Moon's Transit	Sem. Ineq.	Moon's Transit	Sem. Ineq.	Moon's Transit	Sem. Ineq.	Moon's Transit	Sem. Ineq.	Moon's Transit	Sem. Ineq.
	sub.		sub.		sub.		sub.		add
0h 0m	0h 0m	2h 30m	0h 36m	5h 0m	1h 3m	7h 30m	0h 30m	10h 0m	0h 16m
10	0 2	40	0 38	10	1 4	40	0 25	10	0 16
20	0 4	50	0 41	20	1 5	50	0 20	20	0 15
30	0 6	3 0	0 43	30	1 5	8 0	0 15	30	0 15
40	0 8	10	0 45	40	1 5	10	0 10	40	0 14
50	0 11	20	0 47	50	1 4	20	0 5	50	0 12
1 0	0 13	30	0 49	6 0	1 3	30	0 1	11 0	0 11
							add		
10	0 15	40	0 51	10	1 1	40	0 3	10	0 10
20	0 18	50	0 53	20	0 59	50	0 6	20	0 8
30	0 20	4 0	0 55	30	0 56	9 0	0 9	30	0 6
40	0 23	10	0 57	40	0 52	10	0 12	40	0 4
50	0 25	20	0 59	50	0 48	20	0 14	50	0 2
2 0	0 28	30	1 0	7 0	0 44	30	0 15	12 0	0 0
10	0 30	40	1 1	10	0 39	40	0 15		
20	0 33	50	1 2	20	0 35	50	0 16		

TABLE 16.

APPROXIMATE RISE AND FALL OF THE TIDE AT ANY TIME FROM HIGH OR LOW WATER

Range of the Tide in feet	0h 0m	0h 20m	0h 40m	1h 0m	1h 20m	1h 40m	2h 0m	2h 20m	2h 40m	3h 0m	3h 20m	3h 40m	4h 0m	4h 20m	4h 40m	5h 0m	5h 20m	5h 40m	6h 0m	Range of the Tide in feet
0	0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0
2	0	0·0	0·1	0·1	0·2	0·4	0·5	0·7	0·8	1·0	1·2	1·3	1·5	1·6	1·8	1·9	1·9	2·0	2	2
4	0	0·0	0·1	0·3	0·5	0·7	1·0	1·3	1·7	2·0	2·3	2·7	3·0	3·3	3·5	3·7	3·9	4·0	4·	4
6	0	0·0	0·2	0·4	0·7	1·1	1·5	2·0	2·5	3·0	3·5	4·0	4·5	4·9	5·3	5·6	5·8	6·0	6·	6
8	0	0·1	0·2	0·5	0·9	1·3	2·0	2·6	3·3	4·0	4·7	5·4	6·0	6·6	7·1	7·5	7·8	7·9	8·	8
10	0	0·1	0·3	0·7	1·1	1·8	2·5	3·3	4·1	5·0	5·9	6·7	7·5	8·2	8·9	9·3	9·7	9·9	10·0	10
12	0	0·1	0·4	0·8	1·4	2·1	3·0	3·9	5·0	6·0	7·0	8·1	9·0	9·9	10·6	11·2	11·6	11·8	12·0	12
14	0	0·1	0·4	0·9	1·6	2·5	3·5	4·3	5·8	7·0	8·2	9·4	10·5	11·5	12·4	13·1	13·6	13·9	14·0	14
16	0	0·1	0·5	1·1	1·9	2·9	4·0	5·6	6·6	8·0	9·4	10·7	12·0	13·1	14·1	14·9	15·5	15·9	16·0	16
18	0	0·1	0·6	1·2	2·1	3·1	4·5	5·9	7·4	9·0	10·6	12·1	13·5	14·8	15·9	16·8	17·5	17·0	18·0	18
20	0	0·2	0·6	1·3	2·3	3·6	5·0	6·6	8·3	10·0	11·7	13·4	15·0	16·4	17·7	18·7	19·4	19·8	20·0	20
22	0	0·2	0·7	1·5	2·6	3·9	5·5	7·2	9·1	11·0	12·9	14·8	16·5	18·1	19·4	20·5	21·3	21·8	22·0	22
24	0	0·2	0·7	1·6	2·8	4·3	6·0	7·9	9·9	12·0	14·1	16·1	18·0	19·7	21·2	22·4	23·3	23·8	24·0	24
26	0	0·2	0·8	1·7	3·0	4·6	6·5	8·6	10·7	13·0	15·3	17·4	19·5	21·4	23·0	24·3	25·2	25·8	26·0	26
28	0	0·2	0·8	1·9	3·3	5·0	7·0	9·2	11·6	14·0	16·4	18·8	21·0	23·0	24·7	26·1	27·2	27·8	28·0	28
30	0	0·2	0·9	2·0	3·5	5·4	7·5	9·9	12·4	15·0	17·6	20·1	22·5	24·6	26·5	28·0	29·1	29·8	30·0	30
32	0	0·2	1·0	2·1	3·7	5·7	8·0	10·5	13·2	16·0	18·8	21·5	24·0	26·3	28·3	29·9	31·0	31·8	32·0	32
34	0	0·3	1·0	2·3	4·0	6·1	8·5	11·2	14·0	17·0	20·0	22·8	25·5	27·9	30·0	31·7	33·0	33·7	34·0	34
36	0	0·3	1·1	2·4	4·2	6·4	9·0	11·8	14·9	18·0	21·1	24·2	27·0	29·6	31·8	33·6	34·9	35·7	36·0	36
38	0	0·3	1·1	2·5	4·4	6·8	9·5	12·5	15·7	19·0	22·3	25·5	28·5	31·2	33·6	35·5	36·9	37·7	38·0	38
40	0	0·3	1·2	2·7	4·7	7·1	10·0	13·2	16·5	20·0	23·5	26·8	30·0	32·9	35·3	37·3	38·8	39·7	40·0	40
42	0	0·3	1·3	2·8	4·9	7·5	10·5	13·8	17·4	21·0	24·6	28·2	31·5	34·5	37·1	39·2	40·7	41·7	42·0	42
44	0	0·3	1·3	2·9	5·1	7·9	11·0	14·5	18·2	22·0	25·8	29·5	33·0	36·1	38·9	41·1	42·7	43·7	44·0	44
46	0	0·3	1·4	3·1	5·4	8·2	11·5	15·1	19·0	23·0	27·0	30·9	34·5	37·8	40·6	42·9	44·6	45·7	46·0	46
48	0	0·4	1·4	3·2	5·6	8·6	12·0	15·8	19·8	24·0	28·2	32·0	36·0	39·4	42·4	45·8	44·6	47·6	48·0	48
50	0	0·4	1·5	3·3	5·9	8·9	12·5	17·4	20·7	25·0	29·3	33·6	37·5	41·1	44·1	46·7	48·5	49·6	50·0	50

TABLE 17.

ARC.

°	H. M.	′	M. S.	″	S.
0	0 0	0	0 0	0	0·00
1	0 4	1	0 4	1	0·07
2	0 8	2	0 8	2	0·13
3	0 12	3	0 12	3	0·20
4	0 16	4	0 16	4	0·27
5	0 20	5	0 20	5	0·33
6	0 24	6	0 24	6	0·40
7	0 28	7	0 28	7	0·47
8	0 32	8	0 32	8	0·53
9	0 36	9	0 36	9	0·60
10	0 40	10	0 40	10	0·67
11	0 44	11	0 44	11	0·73
12	0 48	12	0 48	12	0·80
13	0 52	13	0 52	13	0·87
14	0 56	14	0 56	14	0·93
15	1 0	15	1 0	15	1·00
16	1 4	16	1 4	16	1·07
17	1 8	17	1 8	17	1·13
18	1 12	18	1 12	18	1·20
19	1 16	19	1 16	19	1·27
20	1 20	20	1 20	20	1·33
30	2 0	21	1 24	21	1·40
40	2 40	22	1 28	22	1·47
50	3 20	23	1 32	23	1·53
60	4 0	24	1 36	24	1·60
70	4 40	25	1 40	25	1·67
80	5 20	26	1 44	26	1·73
90	6 0	27	1 48	27	1·80
100	6 40	28	1 52	28	1·87
110	7 20	29	1 56	29	1·93
120	8 0	30	2 0	30	2·00
130	8 40	31	2 4	31	2·07
140	9 20	32	2 8	32	2·13
150	10 0	33	2 12	33	2·20
160	10 40	34	2 16	34	2·27
170	11 20	35	2 20	35	2·33
180	12 0	36	2 24	36	2·40
		37	2 28	37	2·47
		38	2 32	38	2·53
		39	2 36	39	2·60
		40	2 40	40	2·67
		41	2 44	41	2·73
		42	2 48	42	2·80
		43	2 52	43	2·87
		44	2 56	44	2·93
		45	3 0	45	3·00
		46	3 4	46	3·07
		47	3 8	47	3·13
		48	3 12	48	3·20
		49	3 16	49	3·27
		50	3 20	50	3·33
		51	3 24	51	3·40
		52	3 28	52	3·47
		53	3 32	53	3·53
		54	3 36	54	3·60
		55	3 40	55	3·67
		56	3 44	56	3·73
		57	3 48	57	3·80
		58	3 52	58	3·87
		59	3 56	59	3·93

TABLE 18

TIME.

H.	°	M.	° ′	S.	′ ″	10ths	″
0	0	0	0 0	0	0 0	0·0	0·0
1	15	1	0 15	1	0 15	0·1	1·5
2	30	2	0 30	2	0 30	0·2	3·0
3	45	3	0 45	3	0 45	0·3	4·5
4	60	4	1 0	4	1 0	0·4	6·0
5	75	5	1 15	5	1 15	0·5	7·5
6	90	6	1 30	6	1 30	0·6	9·0
7	105	7	1 45	7	1 45	0·7	10·5
8	120	8	2 0	8	2 0	0·8	12·0
9	135	9	2 15	9	2 15	0·9	13·5
10	150	10	2 30	10	2 30	1·0	15·0
11	165	11	2 45	11	2 45		
12	180	12	3 0	12	3 0		
13	195	13	3 15	13	3 15		
14	210	14	3 30	14	3 30		
15	225	15	3 45	15	3 45		
16	240	16	4 0	16	4 0		
17	255	17	4 15	17	4 15		
18	270	18	4 30	18	4 30		
19	285	19	4 45	19	4 45		
20	300	20	5 0	20	5 0		
21	315	21	5 15	21	5 15		
22	330	22	5 30	22	5 30		
23	345	23	5 45	23	5 45		
24	360	24	6 0	24	6 0		
		25	6 15	25	6 15		
		26	6 30	26	6 30		
		27	6 45	27	6 45		
		28	7 0	28	7 0		
		29	7 15	29	7 15		
		30	7 30	30	7 30		
		31	7 45	31	7 45		
		32	8 0	32	8 0		
		33	8 15	33	8 15		
		34	8 30	34	8 30		
		35	8 45	35	8 45		
		36	9 0	36	9 0		
		37	9 15	37	9 15		
		38	9 30	38	9 30		
		39	9 45	39	9 45		
		40	10 0	40	10 0		
		41	10 15	41	10 15		
		42	10 30	42	10 30		
		43	10 45	43	10 45		
		44	11 0	44	11 0		
		45	11 15	45	11 15		
		46	11 30	46	11 30		
		47	11 45	47	11 45		
		48	12 0	48	12 0		
		49	12 15	49	12 15		
		50	12 30	50	12 30		
		51	12 45	51	12 45		
		52	13 0	52	13 0		
		53	13 15	53	13 15		
		54	13 30	54	13 30		
		55	13 45	55	13 45		
		56	14 0	56	14 0		
		57	14 15	57	14 15		
		58	14 30	58	14 30		
		59	14 45	59	14 45		

CORRECTION OF THE SUN'S DECLINATION AT NOON, AT SEA,

FOR LONGITUDE AND FOR TIME

Long.	Declination																			Time from Noon
	0°	2°	4°	6°	8°	10°	12°	14°	16°	17°	18°	19°	20°	21°	21¼°	22°	22½°	23°	23¼°	
0°	0′	0′	0′	0′	0′	0′	0′	0′	0′	0′	0′	0′	0′	0′	0′	0′	0′	0′	0′	0h 0m
10	0·7	0·7	0·7	0·6	0·6	0·6	0·6	0·5	0·5	0·5	0·4	0·4	0·3	0·3	0·3	0·2	0·2	0·2	0·1	0 40
20	1·3	1 3	1·3	1·3	1·2	1·2	1·1	1·0	1·0	0·9	0·9	0·8	0·7	0·6	0·6	0·5	0·4	0·3	0·2	1 20
30	2·0	2·0	1·9	1·9	1·8	1·8	1·7	1·6	1·5	1·4	1·3	1·2	1·0	0·9	0·8	0·7	0·6	0·4	0·3	2 0
40	2·6	2·6	2·6	2·5	2·5	2·4	2·3	2·1	2·0	1·8	1·7	1·6	1·4	1·2	1·0	0·9	0·8	0·5	0·4	2 40
50	3·3	3·3	3·3	3·2	3·1	3·0	2·8	2·7	2·4	2·3	2·1	2·0	1·7	1·5	1·3	1·1	1·0	0·6	0·4	3 20
60	3·9	3·9	3·9	3·8	3·7	3·6	3·4	3·2	2·9	2·8	2·6	2·4	2·1	1·8	1·6	1·4	1·2	0·8	0·5	4 0
70	4·6	4·6	4·5	4·5	4·3	4·2	4·0	3·7	3·4	3·2	3·0	2·8	2·4	2·1	1·8	1·6	1·4	0·9	0·6	4 40
80	5·2	5·2	5·1	5·1	5·0	4·8	4·5	4·2	3·9	3·7	3·4	3·2	2·8	2·4	2·1	1·9	1·6	1·0	0·7	5 20
90	5·9	5·9	5·8	5·7	5·6	5·4	5·1	4·8	4·4	4·1	3·9	3·6	3·2	2·7	2·4	2·1	1·8	1·1	0·8	6 0
100	6·5	6·5	6·4	6·3	6·2	6·0	5·7	5·3	4·8	4·6	4·3	3·9	3·6	3·0	2·7	2·3	2·0	1·3	0·9	6 40
110	7.2	7·2	7·1	7·0	6·8	6·6	6·3	5·9	5·3	5·0	4·8	4·3	3·9	3·3	3·0	2·5	2·2	1·4	0·9	7 20
120	7·8	7·8	7·7	7·6	7·4	7·2	6·8	6·4	5·8	5·5	5·2	4·7	4·3	3·6	3·2	2·8	2·4	1·5	1·0	8 0
130	8·5	8·5	8·4	8·3	8·0	7·8	7·4	7·0	6·2	5·9	5·6	5·1	4·6	3·9	3·5	3·0	2·6	1·6	1·1	8 40
140	9·1	9·1	9·0	8·9	8·7	8·3	8·0	7·5	6·7	6·4	6·0	5·5	5·0	4·2	3·8	3·3	2·8	·8	1·2	9 20
150	9·8	9·8	9·7	9·5	9·3	9·0	8·5	8·0	7·2	6·8	6·5	5·9	5·3	4·4	4·1	3·5	3·0	1·9	1·3	10 0
160	10·5	10·4	10·3	10·2	9·9	9·6	9·1	8·6	7·7	7·3	6·9	6·3	5·7	4·7	4·4	3·7	3·2	2·0	1·4	10 40
170	11·1	11·1	11·0	10·8	10·5	10·2	9·7	9·1	8·2	7·8	7·4	6·7	6·0	5·1	4·6	4·0	3·4	2·2	1·5	11 20
180	11·8	11·7	11·6	11·4	11·1	10·8	10·3	9·6	8·8	8·3	7·9	7·2	6·4	5·5	4·9	4·3	3·6	2·3	1·6	12 0

In W. Long
When the Declin. is { *increasing*, add. / *decreasing*, sub.

In E. Long.
When the Declin. is { *increasing*, sub. / *decreasing*, add.

For Time, when the Declin. is *increasing*, add , when the Declin. is *decreasing*, sub.

TABLE 20

CORRECTION OF THE EQUATION OF TIME, AT NOON, AT SEA,

FOR LONGITUDE AND FOR TIME

Long.	Daily Variation																Time from Noon
	0s	2s	4s	6s	8s	10s	12s	14s	16s	18s	20s	22s	24s	26s	28s	30s	
0°	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6h 0m
10	0	0·1	0·1	0·2	0·2	0·3	0·3	0·4	0·4	0·5	0·6	0·6	0·7	0·7	0·8	0·8	0 40
20	0	0·1	0·2	0·3	0·4	0·6	0·7	0·8	0·9	1·0	1·1	1·2	1·3	1·4	1·5	1·7	1 20
30	0	0·2	0·3	0·5	0·7	0·8	1·0	1·2	1·3	1·5	1·7	1·8	2·0	2·2	2·3	2·5	2 0
40	0	0·2	0·4	0·7	0·9	1·1	1·3	1·6	1·8	2·0	2·2	2·4	2·7	2·0	3·1	3·3	2 40
50	0	0·3	0·6	0·8	1·1	1·4	1·7	1·9	2·2	2·5	2·8	3·1	3·3	3 6	3·9	4·2	3 20
60	0	0·3	0·7	1·0	1·3	1·7	2·0	2·3	2·7	3·0	3·3	3·7	4·0	4·3	4·7	5·c	4 0
70	0	0·4	0·8	1·2	1·6	1·9	2·3	2·7	3·1	3·5	3·9	4·3	4·7	5·1	5·4	5·8	4 40
80	0	0·4	0·9	1·3	1·8	2·2	2·7	3·1	3·6	4·0	4·4	4·9	5·3	5·8	6·2	6·7	5 20
90	0	0·5	1·0	1·5	2·0	2·5	3·0	3·5	4·0	4·5	5·0	5·5	6·0	6·5	7 0	7·4	6 0
100	0	0·6	1·1	1·7	2·2	2·8	3·3	3·9	4·4	5·0	5·6	6·1	6·7	7·2	7·8	8·3	6 40
110	0	0·6	1·2	1·8	2·4	3·1	3·7	4·3	4·9	5·5	6·1	6·7	7·3	7·9	8·6	9·2	7 20
120	0	0·7	1·3	2·0	2·7	3·3	4·0	4·7	5·3	6·0	6·7	7·3	8·0	8·7	9·3	10·c	8 0
130	0	0·7	1·4	2·2	2·9	3·6	4·3	5·1	5·8	6·5	7·2	7·9	8·7	9·4	10·1	10·8	8 40
140	0	0·8	1·6	2·3	3·1	3·9	4·7	5·4	6·2	7·0	7·8	8·6	9·3	10·1	10·9	11·7	9 20
150	0	0·8	1·7	2·5	3·3	4·2	5·0	5·8	6·7	7·5	8·3	9·2	10·0	10·8	11·7	12·5	10 10
160	0	0·9	1·8	2·7	3·6	4·4	5·3	6·2	7·1	8·0	8·9	9·8	10·7	11·6	12·4	13·3	10 40
170	0	0·9	1·9	2·8	3·8	4·7	5·7	6·6	7·6	8·5	9·4	10·4	11·3	12·3	13·2	14·2	11 20
180	0	1·0	2·0	3·0	4·0	5·0	6·0	7·0	8·0	9·0	10·0	11·0	12·0	13·0	14·0	15·0	12 0

In W. Long.
When the Equat. is { *increasing*, add. / *decreasing*, sub.

In E. Long.
When the Equat. is { *increasing*, sub. / *decreasing*, add.

For Time, when the Equat. is *increasing*, add , when the Equat. is *decreasing*, sub.

FOR REDUCING DAILY AND TWELVE-HOURLY VARIATIONS

Interval 24h	Interval 12h	Variation in 24h or in 12h: 1′ 0″	1′ 30″	2′ 0″	2′ 30″	3′ 0″	3′ 30″	4′ 0″	4′ 30″	5′ 0″	5′ 30″
0h 0m	0h 0m	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″
30	15	0 1·2	0 1·9	0 2·5	0 3·1	0 3·7	0 4·4	0 5	0 5·6	0 6·2	0 6·9
1 0	30	0 2·5	0 3·7	0 5	0 6·2	0 7·5	0 8·7	0 10	0 11·2	0 12·5	0 13·7
30	45	0 3·7	0 5·6	0 7·5	0 9·4	0 11·2	0 13·1	0 15	0 16·9	0 18·7	0 20·6
2 0	1 0	0 5	0 7·5	0 10	0 12·5	0 15	0 17·5	0 20	0 22·5	0 25	0 27·5
30	15	0 6·2	0 9·3	0 12·5	0 15·6	0 18·7	0 21·9	0 25	0 28·1	0 31·2	0 34·4
3 0	30	0 7·5	0 11·2	0 15	0 18·7	0 22·5	0 26·2	0 30	0 33·7	0 37·5	0 41·2
30	45	0 8·7	0 13·1	0 17·5	0 21·9	0 26·2	0 30·6	0 35	0 39·4	0 43·7	0 48·1
4 0	2 0	0 10	0 15	0 20	0 25	0 30	0 35	0 40	0 45	0 50	0 55
30	15	0 11·2	0 16·8	0 22·5	0 28·1	0 33·7	0 39·4	0 45	0 50·6	0 56·2	1 1·9
5 0	30	0 12·5	0 18·7	0 25	0 31·2	0 37·5	0 43·7	0 50	0 56·2	1 2·5	1 8·7
30	45	0 13·7	0 20·6	0 27·5	0 34·4	0 41·2	0 48·1	0 55	1 1·9	1 8·7	1 15·6
6 0	3 0	0 15	0 22·5	0 30	0 37·5	0 45	0 52·5	1 0	1 7·5	1 15	1 22·5
30	15	0 16·2	0 24·4	0 32·5	0 40·6	0 48·7	0 56·9	1 5	1 13·1	1 21·2	1 29·4
7 0	30	0 17·5	0 26·2	0 35	0 43·7	0 52·5	1 1·2	1 10	1 18·7	1 27·5	1 36·2
30	45	0 18·7	0 28·1	0 37·5	0 46·9	0 56·2	1 5·6	1 15	1 24·4	1 33·7	1 43·1
8 0	4 0	0 20	0 30	0 40	0 50	1 0	1 10	1 20	1 30	1 40	1 50
30	15	0 21·2	0 31·9	0 42·5	0 53·1	1 3·7	1 14·4	1 25	1 35·6	1 46·2	1 56·9
9 0	30	0 22·5	0 33·7	0 45	0 56·2	1 7·5	1 18·7	1 30	1 41·2	1 52·5	2 3·7
30	45	0 23·7	0 35·6	0 47·5	0 59·3	1 11·2	1 23·1	1 35	1 46·9	1 58·7	2 10·6
10 0	5 0	0 25	0 37·5	0 50	1 2·4	1 15	1 27·5	1 40	1 52·5	2 5	2 17·5
30	15	0 26·2	0 39·4	0 52·5	1 5·6	1 18·7	1 31·9	1 45	1 58·1	2 11·2	2 24·4
11 0	30	0 27·5	0 41·2	0 55	1 8·7	1 22·5	1 36·2	1 50	2 3·7	2 17·5	2 31·2
30	45	0 28·7	0 43·1	0 57·5	1 11·8	1 26·2	1 40·6	1 55	2 9·4	2 23·7	2 38·1
12 0	6 0	0 30	0 45	1 0	1 15	1 30	1 45	2 0	2 15	2 30	2 45
30	15	0 31·2	0 46·9	1 2·5	1 18·1	1 33·7	1 49·4	2 5	2 20·6	2 36·2	2 51·9
13 0	30	0 32·5	0 48·7	1 5	1 21·4	1 37·5	1 53·7	2 10	2 26·2	2 42·5	2 58·7
30	45	0 33·7	0 50·6	1 7·5	1 24·4	1 41·2	1 58·1	2 15	2 31·9	2 48·7	3 5·6
14 0	7 0	0 35	0 52·5	1 10	1 27·5	1 45	2 2·5	2 20	2 37·5	2 55	3 12·5
30	15	0 36·2	0 54·4	1 12·5	1 30·6	1 48·7	2 6·9	2 25	2 43·1	3 1·2	3 19·4
15 0	30	0 37·5	0 56·2	1 15	1 33·7	1 52·5	2 11·2	2 30	2 48·7	3 7·5	3 26·2
30	45	0 38·7	0 58·1	1 17·5	1 36·8	1 56·2	2 15·6	2 35	2 54·4	3 13·7	3 33·1
16 0	8 0	0 40	1 0	1 20	1 40	2 0	2 20	2 40	3 0	3 20	3 40
30	15	0 41·2	1 1·9	1 22·5	1 43·1	2 3·7	2 24·4	2 45	3 5·6	3 26·2	3 46·9
17 0	30	0 42·5	1 3·7	1 25	1 46·2	2 7·5	2 28·7	2 50	3 11·2	3 32·5	3 53·7
30	45	0 43·7	1 5·6	1 27·5	1 49·3	2 11·2	2 33·1	2 55	3 16·9	3 38·7	4 0·6
18 0	9 0	0 45	1 7·5	1 30	1 52·5	2 15	2 37·5	3 0	3 22·5	3 45	4 7·5
30	15	0 46·2	1 9·3	1 32·5	1 55·6	2 18·7	2 41·9	3 5	3 28·1	3 51·2	4 14·4
19 0	30	0 47·5	1 11·2	1 35	1 58·7	2 22·5	2 46·2	3 10	3 33·7	3 57·5	4 21·2
30	45	0 48·7	1 13·1	1 37·5	2 1·9	2 26·2	2 50·6	3 15	3 39·4	4 3·7	4 28·1
20 0	10 0	0 50	1 15	1 40	2 5	2 30	2 55	3 20	3 45	4 10	4 35
30	15	0 51·2	1 16·8	1 42·5	2 8·1	2 33·7	2 59·4	3 25	3 50·6	4 16·2	4 41·9
21 0	30	0 52·5	1 18·7	1 45	2 11·2	2 37·5	3 3·7	3 30	3 56·2	4 22·5	4 48·7
30	45	0 53·7	1 20·6	1 47·5	2 14·3	2 41·2	3 8·1	3 35	4 1·9	4 28·7	4 55·6
22 0	11 0	0 55	1 22·5	1 50	2 17·4	2 45	3 12·5	3 40	4 7·5	4 35	5 2·5
30	15	0 56·2	1 24·4	1 52·5	2 20·6	2 48·7	3 16·9	3 45	4 13·1	4 41·2	5 9·4
23 0	30	0 57·5	1 26·2	1 55	2 23·7	2 52·5	3 21·2	3 50	4 18·7	4 47·5	5 16·2
30	45	0 58·7	1 28·1	1 57·5	2 26·8	2 56·2	3 25·6	3 55	4 24·4	4 53·7	5 23·1
24 0	12 0	1 0	1 30	2 0	2 30	3 0	3 30	4 0	4 30	5 0	5 30
30	15	1 1·2	1 31·9	2 2·5	2 33·1	3 3·7	3 34·4	4 5	4 35·6	5 6·2	5 36·9
25 0	30	1 2·5	1 33·7	2 5	2 36·2	3 7·5	3 38·7	4 10	4 41·2	5 12·5	5 43·7
30	45	1 3·7	1 35·6	2 7·5	2 39·4	3 11·2	3 43·1	4 15	4 46·9	5 18·7	5 50·6
26 0	13 0	1 5	1 37·5	2 10	2 42·5	3 15	3 47·5	4 20	4 52·5	5 25	5 57·5
30	15	1 6·2	1 39·4	2 12·5	2 45·6	3 18·7	3 51·9	4 25	4 58·1	5 31·2	6 4·4
27 0	30	1 7·5	1 41·2	2 15	2 48·7	3 22·5	3 56·2	4 30	5 3·7	5 37·5	6 11·2
30	45	1 8·7	1 43·1	2 17·5	2 51·9	3 26·2	4 0·6	4 35	5 9·4	5 43·7	6 18·1
28 0	14 0	1 10	1 45	2 20	2 55	3 30	4 5	4 40	5 15	5 50	6 25
30	15	1 11·2	1 46·9	2 22·5	2 58·1	3 33·7	4 9·4	4 45	5 20·6	5 56·2	6 31·9
29 0	30	1 12·5	1 48·7	2 25	3 1·2	3 37·5	4 13·7	4 50	5 26·2	6 2·5	6 38·7
30	45	1 13·7	1 50·6	2 27·5	3 4·3	3 41·2	4 18·1	4 55	5 31·9	6 8·7	6 45·6
30 0	15 0	1 15	1 52·5	2 30	3 7·5	3 45	4 22·5	5 0	5 37·5	6 15	6 52·5

FOR REDUCING DAILY AND TWELVE-HOURLY VARIATIONS

Interval 24h	Interval 12h	Variation in 24h or in 12h: 6′ 0″	6′ 30″	7′ 0″	7′ 30″	8′ 0″	8′ 30″	9′ 0″	9′ 30″	10′ 0″	10′ 30″
0h 0m	0h 0m	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″
30	15	0 7·5	0 8·1	0 8·7	0 9·4	0 10	0 10·6	0 11·2	0 11·9	0 12·5	0 13·1
1 0	30	0 15	0 16·2	0 17·5	0 18·7	0 20	0 21·2	0 22·5	0 23·7	0 25	0 26·2
30	45	0 22·5	0 24·4	0 26·2	0 28·1	0 30	0 31·9	0 33·7	0 35·6	0 37·5	0 39·4
2 0	1 0	0 30	0 32·5	0 35	0 37·5	0 40	0 42·5	0 45	0 47·5	0 50	0 52·5
30	15	0 37·5	0 40·6	0 43·7	0 46·9	0 50	0 53·1	0 56·2	0 59·4	1 2·5	1 5·6
3 0	30	0 45	0 48·7	0 52·5	0 56·2	1 0	1 3·7	1 7·5	1 11·2	1 15	1 18·7
30	45	0 52·5	0 56·9	1 1·2	1 5·6	1 10	1 14·4	1 18·7	1 23·1	1 27·5	1 31·9
4 0	2 0	1 0	1 5	1 10	1 15	1 20	1 25	1 30	1 35	1 40	1 45
30	15	1 7·5	1 13·1	1 18·7	1 24·4	1 30	1 35·6	1 41·2	1 46·9	1 52·5	1 58·1
5 0	30	1 15	1 21·2	1 27·5	1 33·7	1 40	1 46·2	1 52·5	1 58·7	2 5	2 11·2
30	45	1 22·5	1 29·4	1 36·2	1 43·1	1 50	1 56·9	2 3·7	2 10·6	2 17·5	2 24·4
6 0	3 0	1 30	1 37·5	1 45	1 52·5	2 0	2 7·5	2 15	2 22·5	2 30	2 37·5
30	15	1 37·5	1 45·6	1 53·7	2 1·9	2 10	2 18·1	2 26·2	2 34·4	2 42·5	2 50·6
7 0	30	1 45	1 53·7	2 2·5	2 11·2	2 20	2 28·7	2 37·5	2 46·2	2 55	3 3·7
30	45	1 52·5	2 1·9	2 11·2	2 20·6	2 30	2 39·4	2 48·7	2 58·1	3 7·5	3 16·9
8 0	4 0	2 0	2 10	2 20	2 30	2 40	2 50	3 0	3 10	3 20	3 30
30	15	2 7·5	2 18·1	2 28·7	2 39·4	2 50	3 0·6	3 11·2	3 21·9	3 32·5	3 43·1
9 0	30	2 15	2 26·2	2 37·5	2 48·7	3 0	3 11·2	3 22·5	3 33·7	3 44	3 56·2
30	45	2 22·5	2 34·4	2 46·2	2 58·1	3 10	3 21·9	3 33·7	3 45·6	3 57·5	4 9·4
10 0	5 0	2 30	2 42·5	2 55	3 7·5	3 20	3 32·5	3 45	3 57·5	4 10	4 22·5
30	15	2 37·5	2 50·6	3 3·7	3 16·9	3 30	3 43·1	3 56·2	4 9·4	4 22·5	4 35·6
11 0	30	2 45	2 58·7	3 12·5	3 26·2	3 40	3 53·7	4 7·5	4 21·2	4 35	4 48·7
30	45	2 52·5	3 6·9	3 21·2	3 35·6	5 50	4 4·4	4 18·7	4 33·1	4 47·5	5 1·9
12 0	6 0	3 0	3 15	3 30	3 45	4 0	4 15	4 30	4 45	5 0	5 15
30	15	3 7·5	3 23·1	3 38·7	3 54·4	4 10	4 25·6	4 41·2	4 56·9	5 12·5	5 28·1
13 0	30	3 15	3 31·2	3 47·5	4 3·7	4 20	4 36·2	4 52·5	5 8·7	5 25	5 41·2
30	45	3 22·5	3 39·4	3 56·2	4 13·1	4 30	4 46·9	5 3·7	5 20·6	5 37 5	5 54·4
14 0	7 0	3 30	3 47·5	4 5	4 22·5	4 40	4 57·5	5 15	5 32·5	5 50	6 7·5
30	15	3 37·5	3 55·6	4 13·7	4 31·9	4 50	5 8·1	5 26·2	5 44·4	6 2·5	6 20·6
15 0	30	3 45	4 3·7	4 22·5	4 41·2	5 0	5 18·7	5 37·5	5 56·2	6 15	6 33·7
30	45	3 52·5	4 11·9	4 31·2	4 50·6	5 10	5 29·4	5 48·7	6 8·1	6 27·5	6 46·9
16 0	8 0	4 0	4 20	4 40	5 0	5 20	5 40	6 0	6 20	6 40	7 0
30	15	4 7·5	4 28·1	4 48·7	5 9·4	5 30	5 50·6	6 11·2	6 31·9	6 52·5	7 13·1
17 0	30	4 15	4 36·2	4 57·5	5 18·7	5 40	6 1·2	6 22·5	6 43·7	7 5	7 26·2
30	45	4 22·5	4 44·4	5 6·2	5 28·1	5 50	6 11·9	6 33·7	6 55·6	7 17·5	7 39·4
18 0	9 0	4 30	4 52·5	5 15	5 37·5	6 0	6 22·5	6 45	7 7·5	7 30	7 52·5
30	15	4 37·5	5 0·6	5 23·7	5 46·9	6 10	6 33·1	6 56·2	7 19·4	7 42·5	8 5·6
19 0	30	4 45	5 8·7	5 32·5	5 56·2	6 20	6 43·7	7 7·5	7 31·2	7 55	8 18·7
30	45	4 52·5	5 16·9	5 41·2	6 5·6	6 30	6 54·4	7 18·7	7 43·1	8 7·5	8 31·9
20 0	10 0	5 0	5 25	5 50	6 15	6 40	7 5	7 30	7 55	8 20	8 45
30	15	5 7·5	5 33·1	5 58·7	6 24·4	6 50	7 15·6	7 41·2	8 7·9	8 32·5	8 58·1
21 0	30	5 15	5 41·2	6 7·5	6 33·7	7 0	7 26·2	7 52·5	8 18·7	8 44	9 11·2
30	45	5 22·5	5 49·4	6 16·2	6 43·1	7 10	7 36·9	8 3·7	8 30·6	8 57·5	9 24·4
22 0	11 0	5 30	5 57·5	6 25	6 52·5	7 20	7 47·5	8 15	8 42·5	9 10	9 37·5
30	15	5 37·5	6 5·6	6 33·7	7 1·9	7 30	7 58·1	8 26·2	8 54·4	9 22·5	9 50·6
23 0	30	5 45	6 13·7	6 42·5	7 11·2	7 40	8 8·7	8 37·5	9 6·2	9 35	10 3·7
30	45	5 52·5	6 21·9	6 51·2	7 20·6	7 50	8 19·4	8 48·7	9 18·1	9 47·5	10 16·9
24 0	12 0	6 0	6 30·5	7 0	7 30	8 0	8 30	9 0	9 30	10 0	10 30
30	15	6 7·5	6 38·1	7 8·7	7 39·4	8 10	8 40·6	9 11·2	9 41·9	10 12·5	10 43·1
25 0	30	6 15	6 46·2	7 17·5	7 48·7	8 20	8 51·2	9 22·5	9 53·7	10 25	10 56·2
30	45	6 22·5	6 54·4	7 26·2	7 58·1	8 30	9 1·9	9 33·7	10 5·6	10 37·5	11 9·4
26 0	13 0	6 30	7 2·5	7 35	8 7·5	8 40	9 12·5	9 45	10 17·5	10 50	11 22·5
30	15	6 37·5	7 10·6	7 43·7	8 16·9	8 50	9 23·1	9 56·2	10 29·4	11 2·5	11 35·6
27 0	30	6 45	7 18·7	7 52·5	8 26·2	9 0	9 33·7	10 7·5	10 41·2	11 15	11 48·7
30	45	6 52·5	7 26·9	8 ·2	8 35·6	9 10	9 44·4	10 18·7	10 53·1	11 27·5	12 1·9
28 0	14 0	7 0	7 35	8 10	8 45	9 20	9 55	10 30	11 5	11 40	12 15
30	15	7 7·5	7 43·1	8 18·7	8 54·4	9 30	10 5·6	10 41·2	11 16·9	11 52·5	12 28·1
29 0	30	7 15	7 51·2	8 27·5	9 3·7	9 40	10 16·2	10 52·5	11 28·7	12 5	12 41·2
30	45	7 22·5	7 59·4	8 36·2	9 13·1	9 50	10 26·9	11 3·7	11 40·6	12 17·5	12 54·4
30 0	15 0	7 30	8 7·5	8 45	9 22·5	10 0	10 37·5	11 15	11 52·5	12 30	13 7·5

FOR REDUCING DAILY AND TWELVE-HOURLY VARIATIONS

Interval 24h	Interval 12h	Variation in 24h or in 12h: 11′ 0″	11′ 30″	12′ 0″	12′ 30″	13′ 0″	13′ 30″	14′ 0″	14′ 30″	15′ 0″	15′ 30″
0h 0m	0h 0m	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″
30	15	0 13·7	0 14·4	0 15	0 15·6	0 16·2	0 16·9	0 17·5	0 18·1	0 18·7	0 19·4
1 0	30	0 27·5	0 28·7	0 30	0 31·2	0 32·5	0 33·7	0 35	0 36·2	0 37·5	0 38·7
30	45	0 41·2	0 43·1	0 45	0 46·9	0 48·7	0 50·6	0 52·5	0 54·4	0 56·2	0 58·1
2 0	1 0	0 55	0 57·5	1 0	1 2·5	1 5	1 7·5	1 10	1 12·5	1 15	1 17·5
30	15	1 8·7	1 11·9	1 15	1 18·1	1 21·2	1 24·4	1 27·5	1 30·6	1 33·7	1 36·9
3 0	30	1 22·5	1 26·2	1 30	1 33·7	1 37·5	1 41·2	1 45	1 48·7	1 52·5	1 56·2
30	45	1 36·2	1 40·6	1 45	1 49·4	1 53·7	1 58·1	2 2·5	1 36·9	2 11·2	2 15·6
4 0	2 0	1 50	1 55	2 0	2 5	2 10	2 15	2 20	2 25	2 30	2 35
30	15	2 3·7	2 9·4	2 15	2 20·6	2 26·2	2 31·9	2 37·5	2 48·1	2 48·7	2 54·4
5 0	30	2 17·5	2 23·7	2 30	2 36·2	2 42·5	2 48·7	2 55	3 1·2	3 7·5	3 13·7
30	45	2 31·2	2 38·1	2 45	2 51·9	2 58·7	3 5·6	3 12·5	3 19·4	3 26·2	3 33·1
6 0	3 0	2 45	2 52·5	3 0	3 7·5	3 15	3 22·5	3 30	3 37·5	3 45	3 52·5
30	15	2 58·7	3 6·9	3 15	3 23·1	3 31·2	3 39·4	3 47·5	3 55·6	4 3·7	4 11·9
7 0	30	3 12·5	3 21·2	3 30	3 38·7	3 47·5	3 56·2	4 5	4 13·7	4 22·5	4 31·2
30	45	3 26·2	3 35·6	3 45	3 54·4	4 3·7	4 13·1	4 23·5	4 31·9	4 41·2	4 50·6
8 0	4 0	3 40	3 50	4 0	4 10	4 20	4 30	4 40	4 50	5 0	5 10
30	15	3 53·7	4 4·4	4 15	4 25·6	4 36·2	4 46·9	4 57·5	5 8·1	5 18·7	5 29·4
9 0	30	4 7·5	4 18·7	4 30	4 41·2	4 52·5	5 3·7	5 15	5 26·2	5 37·5	5 48·7
30	45	4 21·2	4 33·1	4 45	4 56·9	5 8·7	5 20·6	5 32·5	5 44·4	5 56·2	6 8·1
10 0	5 0	4 35	4 47·5	5 0	5 12·5	5 25	5 37·5	5 50	6 2·5	6 15	6 27·5
30	15	4 48·7	5 1·9	5 15	5 28·1	5 41·2	5 54·4	6 7·5	6 20·6	6 33·7	6 46·9
11 0	30	5 2·5	5 26·2	5 30	5 43·7	5 57·5	6 11·2	6 25	6 38·7	6 52·5	7 6·2
30	45	5 16·2	5 40·6	5 45	5 59·4	6 13·7	6 28·1	6 42·5	6 56·9	7 11·2	7 25·6
12 0	6 0	5 30	5 45	6 0	6 15	6 30	6 45	7 0	7 15	7 30	7 45
30	15	5 43·7	5 59·4	6 15	6 30·6	6 46·2	7 1·9	7 17·5	7 33·1	7 48·7	8 4·4
13 0	30	5 57·5	6 13·7	6 30	6 46·2	7 2·5	7 18·7	7 35	7 51·2	8 7·5	8 23·7
30	45	6 11·2	6 28·1	6 45	7 1·9	7 18·7	7 35·6	7 52·5	8 9·4	8 26·2	8 43·1
14 0	7 0	6 25	6 42·5	7 0	7 17·5	7 35	7 52·5	8 10	8 27·5	8 45	9 2·5
30	15	6 38·7	6 56·9	7 15	7 33·1	7 51·2	8 9·4	8 27·5	8 45·6	9 3·7	9 21·9
15 0	30	6 52·5	7 11·2	7 30	7 48·7	8 7·5	8 26·2	8 45	9 3·7	9 22·5	9 41·2
30	45	7 6·2	7 25·6	7 45	8 4·4	8 23·7	8 43·1	9 2·5	9 21·9	9 41·2	10 0·6
16 0	8 0	7 20	7 40	8 0	8 20	8 40	9 0	9 20	9 40	10 0	10 20
30	15	7 33·7	7 54·4	8 15	8 35·6	8 56·2	9 16·9	9 37·5	9 58·1	10 18·7	10 39·4
17 0	30	7 47·5	8 8·7	8 30	8 51·2	9 12·5	9 33·7	9 55	10 16·2	10 37·5	10 58·7
30	45	8 1·2	8 23·1	8 45	9 6·9	9 28·7	9 50·6	10 12·5	10 34·4	10 56·2	11 18·1
18 0	9 0	8 15	8 37·5	9 0	9 22·5	9 45	10 7·5	10 30	10 52·5	11 15	11 37·5
30	15	8 28·7	8 51·9	9 15	9 38·1	10 1·2	10 24·4	10 47·5	11 10·6	11 33·7	11 56·9
19 0	30	8 42·5	9 6·2	9 30	9 53·7	10 17·5	10 41·2	11 5	11 28·7	11 52·5	12 16·2
30	45	8 56·2	9 20·6	9 45	10 9·4	10 33·7	10 58·1	11 23·5	11 46·9	12 11·2	12 35·6
20 0	10 0	9 10	9 35	10 0	10 25	10 50	11 15	11 40	12 5	12 30	12 55
30	15	9 23·7	9 49·4	10 15	10 40·6	11 6·2	11 31·9	11 57·5	12 23·1	12 48·7	13 14·4
21 0	30	9 37·5	10 3·7	10 30	10 56·2	11 22·5	11 48·7	12 15	12 41·2	13 7·5	13 33·7
30	45	9 51·2	10 18·1	10 45	11 11·9	11 38·7	12 5·6	12 32·5	12 59·4	13 26·2	13 53·1
22 0	11 0	10 5	10 32·5	11 0	11 27·5	11 55	12 22·5	12 50	13 17·5	13 45	14 12·5
30	15	10 18·7	10 46·9	11 15	11 43·1	12 11·2	12 39·4	13 7·5	13 35·6	14 3·7	14 31·9
23 0	30	10 32·5	11 1·2	11 30	11 58·7	12 27·5	12 56·2	13 25	13 53·7	14 22·5	14 51·2
30	45	10 46·2	11 15·6	11 45	12 14·4	12 43·7	13 13·1	13 42·5	14 11·9	14 41·2	15 10·6
24 0	12 0	11 0	11 30	12 0	12 30	13 0	13 30	14 0	14 30	15 0	15 30
30	15	11 13·7	11 44·4	12 15	12 45·6	13 16·2	13 46·9	14 17·5	14 48·1	15 18·7	15 49·4
25 0	30	11 27·5	11 58·7	12 30	13 1·2	13 32·5	14 3·7	14 35	15 6·2	15 37·5	16 8·7
30	45	11 41·2	12 13·1	12 45	13 16·9	13 48·7	14 20·6	14 52·5	15 24·4	15 56·2	16 28·1
26 0	13 0	11 55	12 27·5	13 0	13 32·5	14 5	14 37·5	15 10	15 42·5	16 15	16 47·5
30	15	12 8·7	12 41·9	13 15	13 48·1	14 21·2	14 54·4	15 27·5	16 0·6	16 33·7	17 6·9
27 0	30	12 22·5	12 56·2	13 30	14 3·7	14 37·5	15 11·2	15 45	16 18·7	16 52·5	17 26·2
30	45	12 36·2	13 10·6	13 45	14 19·4	14 53·7	15 28·1	16 2·5	16 36·9	17 11·2	17 45·6
28 0	14 0	12 50	13 25	14 0	14 35	15 10	15 45	16 20	16 55	17 30	18 5
30	15	13 3·7	13 39·4	14 15	14 50·6	15 26·2	16 1·9	16 37·5	17 13·1	17 48·7	18 24·4
29 0	30	13 17·5	13 53·7	14 30	15 6·2	15 42·5	16 18·7	16 55	17 31·2	18 7·5	18 43·7
30	45	13 31·2	14 8·1	14 45	15 21·9	15 58·7	16 35·6	17 12·5	17 49·4	18 26·2	19 3·1
30 0	15 0	13 45	14 22·5	15 0	15 37·5	16 15	16 52·5	17 30	18 7·5	18 45	19 22·5

FOR REDUCING DAILY AND TWELVE-HOURLY VARIATIONS

Inter-val 24h	Inter-val 12h	Variation in 24h or in 12h: 16′ 0″	16′ 30″	17′ 0″	17′ 30″	18′ 0″	18′ 30″	19′ 0″	19′ 30″	20′ 0″	20′ 30″
0h 0m	0h 0m	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0 0″	0′ 0″
30	15	0 20	0 20·6	0 21·2	0 21·9	0 22·5	0 23·1	0 23·7	0 24·4	0 25	0 25·6
1 0	30	0 40	0 41·2	0 42·5	0 43·7	0 45	0 46·2	0 47·5	0 48·7	0 50	0 51·2
30	45	1 0	1 1·9	1 3·7	1 5·6	1 7·5	1 9·4	1 11·2	1 13·1	1 15	1 16·9
2 0	1 0	1 20	1 22·5	1 25	1 27·5	1 30	1 32·5	1 35	1 37·5	1 40	1 42·5
30	15	1 40	1 43·1	1 46·2	1 49·4	1 52·5	1 55·6	1 58·7	2 1·9	2 5	2 8·1
3 0	30	2 0	2 3·7	2 7·5	2 11·2	2 15	2 18·7	2 22·5	2 26·2	2 30	2 33·7
30	45	2 20	2 24·4	2 28·7	2 33·1	2 37·5	2 41·9	2 46·2	2 50·6	2 55	2 59·4
4 0	2 0	2 40	2 45	2 50	2 55	3 0	3 5	3 10	3 15	3 20	3 25
30	15	3 0	3 5·6	3 11·2	3 16·9	3 22·5	3 28·1	3 33·7	3 39·4	3 45	3 50·6
5 0	30	3 20	3 26·2	3 32·5	3 38·7	3 45	3 51·2	3 57·5	4 3·7	4 10	4 16·2
30	45	3 40	3 46·9	3 53·7	4 0·6	4 7·5	4 14·4	4 21·2	4 28·1	4 35	4 41·9
6 0	3 0	4 0	4 7·5	4 15	4 22·5	4 30	4 37·5	4 45	4 52·5	5 0	5 7·5
30	15	4 20	4 28·1	4 36·2	4 44·4	4 52·5	5 0·6	5 8·7	5 16·9	5 25	5 33·1
7 0	30	4 40	4 48·7	4 57·5	5 6·2	5 15	5 23·7	5 32·5	5 41·2	5 50	5 58·7
30	45	5 0	5 9·4	5 18·7	5 28·1	5 37·5	5 46·9	5 56·2	6 5·6	6 15	6 24·4
8 0	4 0	5 20	5 30	5 40	5 50	6 0	6 10	6 20	6 30	6 40	6 50
30	15	5 40	5 50·6	6 1·2	6 11·9	6 22·5	6 33·1	6 43·7	6 54·4	7 5	7 15·6
9 0	30	6 0	6 11·2	6 22·5	6 33·7	6 45	6 56·2	7 7·5	7 18·7	7 30	7 41·2
30	45	6 20	6 31·9	6 43·7	6 55·6	7 7·5	7 19·4	7 31·2	7 43·1	7 55	8 6·9
10 0	5 0	6 40	6 52·5	7 5	7 17·5	7 30	7 42·5	7 55	8 7·5	8 20	8 32·5
30	15	7 0	7 13·1	7 26·2	7 39·4	7 52·5	8 5·6	8 18·7	8 31·9	8 45	8 58·1
11 0	30	7 20	7 33·7	7 47·5	8 1·2	8 15	8 28·7	8 42·5	8 56·2	9 10	9 23·7
30	45	7 40	7 54·4	8 8·7	8 23·1	8 37·5	8 51·9	9 6·2	9 20·6	9 35	9 49·4
12 0	6 0	8 0	8 15	8 30	8 45	9 0	9 15	9 30	9 45	10 0	10 15
30	15	8 20	8 35·6	8 51·2	9 6·9	9 22·5	9 38·1	9 53·7	10 9·4	10 25	10 40·6
13 0	30	8 40	8 56·2	9 12·5	9 28·7	9 45	10 1·2	10 17·5	10 33·7	10 50	11 6·2
30	45	9 0	9 16·9	9 33·7	9 50·6	10 7·5	10 24·4	10 41·2	10 58·1	11 15	11 31·9
14 0	7 0	9 20	9 37·5	9 55	10 12·5	10 30	10 47·5	11 5	11 22·5	11 40	11 57·5
30	15	9 40	9 58·1	10 16·2	10 34·4	10 52·5	11 10·6	11 28·7	11 46·9	12 5	12 23·1
15 0	30	10 0	10 18·7	10 37·5	10 56·2	11 15	11 33·7	11 52·5	12 11·2	12 30	12 48·7
30	45	10 20	10 39·4	10 58·7	11 18·1	11 37·5	11 56·9	12 16·2	12 35·6	12 55	13 14·4
16 0	8 0	10 40	11 0	11 20	11 40	12 0	12 20	12 40	13 0	13 20	13 40
30	15	11 0	11 20·6	11 41·2	12 1·9	12 22·5	12 43·1	13 3·7	13 24·4	13 45	14 5·6
17 0	30	11 20	11 41·2	12 2·5	12 23·7	12 45	13 6·2	13 27·5	13 48·7	14 10	14 31·2
30	45	11 40	12 1·9	12 23·7	12 45·6	13 7·5	13 29·4	13 51·2	14 13·1	14 35	14 56·9
18 0	9 0	12 0	12 22·5	12 45	13 7·5	13 30	13 52·5	14 15	14 37·5	15 0	15 22·5
30	15	12 20	12 43·1	13 6·2	13 29·4	13 52·5	14 15·6	14 38·7	15 1·9	15 25	15 48·1
19 0	30	12 40	13 3·7	13 27·5	13 51·2	14 15	14 38·7	15 2·5	15 26·2	15 50	16 13·7
30	45	13 0	13 24·4	13 48·7	14 13·1	14 37·5	15 1·9	15 26·2	15 50·6	16 15	16 39·4
20 0	10 0	13 20	13 45	14 10	14 35	15 0	15 25	15 50	16 15	16 40	17 5
30	15	13 40	14 5·6	14 31·2	14 56·9	15 22·5	15 48·1	16 13·7	16 39·4	17 5	17 30·6
21 0	30	14 0	14 26·2	14 52·5	15 18·7	15 45	16 11·2	16 37·5	17 3·7	17 30	17 56·2
30	45	14 20	14 46·9	15 13·7	15 40·6	16 7·5	16 34·4	17 1·2	17 28·1	17 55	18 21·9
22 0	11 0	14 40	15 7·5	15 35	16 2·5	16 30	16 57·5	17 25	17 52·5	18 20	18 47·5
30	15	15 0	15 28·1	15 56·2	16 24·4	16 52·5	17 20·6	17 48·7	18 16·9	18 45	19 13·1
23 0	30	15 20	15 48·7	16 17·5	16 46·2	17 15	17 43·7	18 12·5	18 41·2	19 10	19 38·7
30	45	15 40	16 9·4	16 38·7	17 8·1	17 37·5	18 6·9	18 36·2	19 5·6	19 35	20 4·4
24 0	12 0	16 0	16 30	17 0	17 30	18 0	18 30	19 0	19 30	20 0	20 30
30	15	16 20	16 50·6	17 21·2	17 51·9	18 22·5	18 53·1	19 23·7	19 54·4	20 25	20 55·6
25 0	30	16 40	17 11·2	17 42·5	18 13·7	18 45	19 16·2	19 47·5	20 18·7	20 50	21 21·2
30	45	17 0	17 31·9	18 3·7	18 35·6	19 7·5	19 39·4	20 11·2	20 43·1	21 15	21 46·9
26 0	13 0	17 20	17 52·5	18 25	18 57·5	19 30	20 2·5	20 35	21 7·5	21 40	22 12·5
30	15	17 40	18 13·1	18 46·2	19 19·4	19 52·5	20 25·6	20 58·7	21 31·9	22 5	22 38·1
27 0	30	18 0	18 33·7	19 7·5	19 41·2	20 15	20 48·7	21 22·5	21 56·2	22 30	23 3·7
30	45	18 20	18 54·4	19 28·7	20 3·1	20 37·5	21 11·9	21 46·2	22 20·6	22 55	23 29·4
28 0	14 0	18 40	19 15	19 50	20 25	21 0	21 35	22 10	22 45	23 20	23 55
30	15	19 0	19 35·6	20 11·2	20 46·9	21 22·5	21 58·1	22 33·7	23 9·4	23 45	24 20·6
29 0	30	19 20	19 56·2	20 32·5	21 8·7	21 45	22 21·2	22 57·5	23 33·7	24 10	24 46·2
30	45	19 40	20 16·9	20 53·7	21 30·6	22 7·5	22 44·4	23 21·2	23 58·1	24 35	25 11·9
30 0	15 0	20 0	20 37·5	21 15	21 52·5	22 30	23 7·5	23 45	24 22·5	25 0	25 37·5

FOR REDUCING DAILY AND TWELVE-HOURLY VARIATIONS

Interval 24ʰ	Interval 12ʰ	Variation in 24ʰ or in 12ʰ: 21′ 0″	21′ 30″	22′ 0″	22′ 30″	23′ 0″	23′ 30″	24′ 0″	24′ 30″	25′ 0″	25′ 30″
0ʰ 0ᵐ	0ʰ 0ᵐ	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″
30	15	0 26·2	0 26·9	0 27·5	0 28·1	0 28·7	0 29·4	0 30	0 30·6	0 31·2	0 31·9
1 0	30	0 52·5	0 53·7	0 55	0 56·2	0 57·5	0 58·7	1 0	1 1·2	1 2·5	1 3·7
30	45	1 18·7	1 20·6	1 22·5	1 24·4	1 26·2	1 28·1	1 30	1 31·9	1 33·7	1 35·6
2 0	1 0	1 45	1 47·5	1 50	1 52·5	1 55	1 57·5	2 0	2 2·5	2 5	2 7·5
30	15	2 11·2	2 14·4	2 17·5	2 20·6	2 23·7	2 26·9	2 30	2 33·1	2 36·2	2 39·4
3 0	30	2 37·5	2 41·2	2 45	2 48·7	2 52·5	2 56·2	3 0	3 3·7	3 7·5	3 11·2
30	45	3 3·7	3 8·1	3 12·5	3 16·9	3 21·2	3 25·6	3 30	3 34·4	3 38·7	3 43·1
4 0	2 0	3 30	3 35	3 40	3 45	3 50	3 55	4 0	4 5	4 10	4 15
30	15	3 56·2	4 1·9	4 7·5	4 13·1	4 18·7	4 24·4	4 30	4 35·6	4 41·2	4 46·9
5 0	30	4 22·5	4 28·7	4 35	4 41·2	4 47·5	4 53·7	5 0	5 6·2	5 12·5	5 18·7
30	45	4 48·7	4 55·6	5 2·5	5 9·4	5 16·2	5 23·1	5 30	5 36·9	5 43·7	5 50·6
6 0	3 0	5 15	5 22·5	5 30	5 37·5	5 45	5 52·5	6 0	6 7·5	6 15	6 22·5
30	15	5 41·2	5 49·4	5 57·5	6 5·6	6 13·7	6 21·9	6 30	6 38·1	6 46·2	6 54·4
7 0	30	6 7·5	6 16·2	6 25	6 33·7	6 42·5	6 51·2	7 0	7 8·7	7 17·5	7 26·2
30	45	6 33·7	6 43·1	6 52·5	7 1·9	7 11·2	7 20·6	7 30	7 39·4	7 48·7	7 58·1
8 0	4 0	7 0	7 10	7 20	7 30	7 40	7 50	8 0	8 10	8 20	8 30
30	15	7 26·2	7 36·9	7 47·5	7 58·1	8 8·7	8 19·4	8 30	8 40·6	8 51·2	9 1·9
9 0	30	7 52·5	8 3·7	8 15	8 26·2	8 37·5	8 48·7	9 0	9 11·2	9 22·5	9 33·7
30	45	8 18·7	8 30·6	8 42·5	8 54·4	9 6·2	9 18·1	9 30	9 41·9	9 53·7	10 5·6
10 0	5 0	8 45	8 57·5	9 10	9 22·5	9 35	9 47·5	10 0	10 12·5	10 25	10 37·5
30	15	9 11·2	9 24·4	9 37·5	9 50·6	10 3·7	10 16·9	10 30	10 43·1	10 56·2	11 9·4
11 0	30	9 37·5	9 51·2	10 5	10 18·7	10 32·5	10 46·2	11 0	11 13·7	11 27·5	11 41·2
30	45	10 3·7	10 18·1	10 32·5	10 46·9	11 1·2	11 15·6	11 30	11 44·4	11 58·7	12 13·1
12 0	6 0	10 30	10 45	11 0	11 15	11 30	11 45	12 0	12 15	12 30	12 45
30	15	10 56·2	11 11·9	11 27·5	11 43·1	11 58·7	12 14·4	12 30	12 45·6	13 1·2	13 16·9
13 0	30	11 22·5	11 38·7	11 55	12 11·2	12 27·5	12 43·7	13 0	13 16·2	13 32·5	13 48·7
30	45	11 48·7	12 5·6	12 22·5	12 39·4	12 56·2	13 13·1	13 30	13 46·9	14 3·7	14 20·6
14 0	7 0	12 15	12 32·5	12 50	13 7·5	13 25	13 42·5	14 0	14 17·5	14 35	14 52·5
30	15	12 41·2	12 59·4	13 17·5	13 35·6	13 53·7	14 11·9	14 30	14 48·1	15 6·2	15 24·4
15 0	30	13 7·5	13 26·2	13 45	14 3·7	14 22·5	14 41·2	15 0	15 18·7	15 37·5	15 56·2
30	45	13 33·7	13 53·1	14 12·5	14 31·9	14 51·2	15 10·6	15 30	15 49·4	16 8·7	16 27·1
16 0	8 0	14 0	14 20	14 40	15 0	15 20	15 40	16 0	16 20	16 40	17 0
30	5	14 26·2	14 46·9	15 7·5	15 28·1	15 48·7	16 9·4	16 30	16 50·6	17 11·2	17 31·9
17 0	30	14 52·5	15 13·7	15 35	15 56·2	16 7·5	16 38·7	17 0	17 21·2	17 42·5	18 3·7
30	45	15 18·7	15 40·6	16 2·5	16 24·4	16 46·2	17 8·1	17 30	17 51·9	18 13·7	18 35·6
18 0	9 0	15 45	16 7·5	16 30	16 52·5	17 15	17 37·5	18 0	18 22·5	18 45	19 7·5
30	15	16 11·2	16 34·4	16 57·5	17 20·6	17 43·7	18 6·9	18 30	18 53·1	19 16·2	19 39·4
19 0	30	16 37·5	17 1·2	17 25	17 48·7	18 12·5	18 36·2	19 0	19 23·7	19 47·5	20 11·2
30	45	17 3·7	17 28·1	17 52·5	18 16·9	18 41·2	19 5·6	19 30	19 54·4	20 18·7	20 43·1
20 0	10 0	17 30	17 55	18 20	18 45	19 10	19 35	20 0	20 25	20 50	21 15
30	15	17 56·2	18 21·9	18 47·5	19 13·1	19 38·7	20 4·4	20 30	20 55·6	21 21·2	21 46·9
21 0	30	18 22·5	18 48·7	19 15	19 41·2	20 7·5	20 33·7	21 0	21 26·2	21 52·5	22 18·7
30	45	18 48·7	19 15·6	19 42·5	20 9·4	20 36·2	21 3·1	21 30	21 56·9	22 23·7	22 50·6
22 0	11 0	19 15	19 42·5	20 10	20 37·5	21 5	21 32·5	22 0	22 27·5	22 55	23 22·5
30	15	19 41·2	20 9·4	20 37·5	21 5·6	21 33·7	22 1·9	22 30	22 58·1	23 26·2	23 54·4
23 0	30	20 7·5	20 36·2	21 5	21 33·7	22 2·5	22 31·2	23 0	23 28·7	23 57·5	24 26·2
30	45	20 33·7	21 3·1	21 32·5	22 1·9	22 31·2	23 0·6	23 30	23 59·4	24 28·7	24 58·1
24 0	12 0	21 0	21 30	22 0	22 30	23 0	23 30	24 0	24 30	25 0	25 30
30	15	21 26·2	21 56·9	22 27·5	22 58·1	23 28·7	23 59·4	24 30	25 0·6	25 31·2	26 1·9
25 0	30	21 52·5	22 23·7	22 55	23 26·2	23 57·5	24 28·7	25 0	25 31·2	26 2·5	26 33·7
30	45	22 18·7	22 50·6	23 22·5	23 54·4	24 26·2	24 58·1	25 30	26 1·9	26 33·7	27 5·6
26 0	13 0	22 45	23 17·5	23 50	24 22·5	24 55	25 27·5	26 0	26 32·5	27 5	27 37·5
30	15	23 11·2	23 44·4	24 17·5	24 50·6	25 23·7	25 56·9	26 30	27 3·1	27 36·2	28 9·4
27 0	30	23 37·5	24 11·2	24 45	25 18·7	25 52·5	26 26·2	27 0	27 33·7	28 7·5	28 41·2
30	45	24 3·7	24 38·1	25 12·5	25 46·9	26 21·2	26 55·6	27 30	28 4·4	28 38·7	29 13·1
28 0	14 0	24 30	25 5	25 40	26 15	26 50	27 25	28 0	28 35	29 10	29 45
30	15	24 56·2	25 31·9	26 7·5	26 43·1	27 18·7	27 54·4	28 30	29 5·6	29 41·2	30 16·9
29 0	30	25 22·5	25 58·	26 35	27 11·2	27 47·5	28 23·7	29 0	29 36·2	30 12·5	30 48·7
30	45	25 48·7	26 25·6	27 2·5	27 39·4	28 16·2	28 53·1	29 30	30 6·9	30 43·7	31 20·6
30 0	15 0	26 15	26 52·5	27 30	28 7·5	28 45	29 22·5	30 0	30 37·5	31 15	31 52·5

FOR REDUCING DAILY AND TWELVE-HOURLY VARIATIONS

Interval 24h	Interval 12h	Variation in 24h or in 12h: 26′ 0″	26′ 30″	27′ 0″	27′ 30″	28′ 0″	28′ 30″	29′ 0″	29′ 30″	30′ 0″	30′ 30″
0h 0m	0h 0m	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″
30	15	0 32·5	0 33·1	0 33·7	0 34·4	0 35	0 35·6	0 36·2	0 36·9	0 37·5	0 38·1
1 0	30	1 5	1 6·2	1 7·5	1 8·7	1 10	1 11·2	1 12·5	1 13·7	1 15	1 16·2
30	45	1 37·5	1 39·4	1 41·2	1 43·1	1 45	1 46·9	1 48·7	1 50·6	1 52·5	1 54·4
2 0	1 0	2 10	2 12·5	2 15	2 17·5	2 20	2 22·5	2 25	2 27·5	2 30	2 32·5
30	15	2 42·5	2 45·6	2 48·7	2 51·9	2 55	2 58·1	3 1·2	3 4·4	3 7·5	3 10·6
3 0	30	3 15	3 18·7	3 22·5	3 26·2	3 30	3 33·7	3 37·5	3 41·2	3 45	3 48·7
30	45	3 47·5	3 51·9	3 56·2	4 0·6	4 5	4 9·4	4 13·7	4 18·1	4 22·5	4 26·9
4 0	2 0	4 20	4 25	4 30	4 35	4 40	4 45	4 50	4 55	5 0	5 5
30	15	4 52·5	4 58·1	5 3·7	5 9·4	5 15	5 20·6	5 26·2	5 31·9	5 37·5	5 43·1
5 0	30	5 25	5 31·2	5 37·5	5 43·7	5 50	5 56·2	6 2·5	6 8·7	6 15	6 21·2
30	45	5 57·5	6 4·4	6 11·2	6 18·1	6 25	6 31·9	6 38·7	6 45·6	6 52·5	6 59·4
6 0	3 0	6 30	6 37·5	6 45	6 52·5	7 0	7 7·5	7 15	7 22·5	7 30	7 37·5
30	15	7 2·5	7 10·6	7 18·7	7 26·9	7 35	7 43·1	7 51·2	7 59·4	8 7·5	8 15·6
7 0	30	7 35	7 43·7	7 52·5	8 ·2	8 10	8 18·7	8 27·5	8 36·2	8 45	8 53·7
30	45	8 7·5	8 16·9	8 26·2	8 35·6	8 45	8 54·4	9 3·7	9 13·1	9 22·5	9 31·9
8 0	4 0	8 40	8 50	9 0	9 10	9 20	9 30	9 40	9 50	10 0	10 10
30	15	9 12·5	9 23·1	9 33·7	9 44·4	9 55	10 5·6	10 16·2	10 26·9	10 37·5	10 48·1
9 0	30	9 45	9 56·2	10 7·5	10 18·7	10 30	10 41·2	10 52·5	11 3 7	11 15	11 26·2
30	45	10 17·5	10 29·4	10 41·2	10 53·1	11 5	11 16·9	11 28·7	11 40·6	11 52·5	12 4·4
10 0	5 0	10 50	11 2·5	11 15	11 27·5	11 40	11 52·5	12 5	12 17·5	12 30	12 42·5
30	15	11 22·5	11 35·6	11 48·7	12 1·9	12 15	12 28·1	12 41·2	12 54·4	13 7·5	13 20·6
11 0	30	11 55	12 8·7	12 22·5	12 36·2	12 50	13 3·7	13 17·5	13 31·2	13 45	13 58·7
30	45	12 27·5	12 41·9	12 56·2	13 10·6	13 25	13 39·4	13 53·7	14 8·1	14 22·5	14 36·9
12 0	6 0	13 0	13 15	13 30	13 45	14 0	14 15	14 30	14 45	15 0	15 15
30	15	13 32·5	13 48·1	14 3·7	14 19·4	14 35	14 50·6	15 6·2	15 21·9	15 37·5	15 53·1
13 0	30	14 5	14 21·2	14 37·5	14 53·7	15 10	15 26·2	15 42·5	15 58·7	16 15	16 31·2
30	45	14 37·5	14 54·4	15 11·2	15 28·1	15 45	16 1·9	16 18·7	16 35·6	16 52·5	17 9·4
14 0	7 0	15 10	15 27·5	15 45	16 2·5	16 20	16 37·5	16 55	17 12·5	17 30	17 47·5
30	15	15 42·5	16 0·6	16 18·7	16 36·9	16 55	17 13·1	17 31·2	17 49·4	18 7·5	18 25·6
15 0	30	16 15	16 33·7	16 52·5	17 11·2	17 30	17 48·7	18 7·5	18 26·2	18 45	19 3·7
30	45	16 47·5	17 6·9	17 26·2	17 45·6	18 5	18 24·4	18 43·7	19 3·1	19 22·5	19 41·9
16 0	8 0	17 20	17 40	18 0	18 20	18 40	19 0	19 20	19 40	20 0	20 20
30	15	17 52·5	18 13·1	18 33·7	18 54·4	19 15	19 35·6	19 56·2	20 16·9	20 37·5	20 58·1
17 0	30	18 25	18 46·2	19 7·5	19 28·7	19 50	20 11·2	20 32·5	20 53·7	21 15	21 36·2
30	45	18 57·5	19 19·4	19 41·2	20 3·1	20 25	20 46·9	21 8·7	21 30·6	21 52·5	22 14·4
18 0	9 0	19 30	19 52·5	20 15	20 37·5	21 0	21 22·5	21 45	22 7·5	22 30	22 52·5
30	15	20 2·5	20 25·6	20 48·7	21 11·9	21 35	21 58·1	22 21·2	22 44·4	23 7·5	23 30·6
19 0	30	20 35	20 58·7	21 22·5	21 46·2	22 10	22 33·7	22 57·5	23 21·2	23 45	24 8·7
30	45	21 7·5	21 31·9	21 56·2	22 20·6	22 45	23 9·4	23 33·7	23 58·1	24 22·5	24 46·9
20 0	10 0	21 40	22 5	22 30	22 55	23 20	23 45	24 10	24 35	25 0	25 25
30	15	22 12·5	22 38·1	23 3·7	23 29·4	23 55	24 20·6	25 46·2	25 11·9	25 37·5	26 3·1
21 0	30	22 45	23 11·2	23 37·5	24 3·7	24 30	24 56·2	25 22·5	25 48·7	26 15	26 41·2
30	45	23 17·5	23 44·4	24 11·2	24 38·1	25 5	25 31·9	25 58·7	26 25·6	26 52·5	27 19·4
22 0	11 0	23 50	24 17·5	24 45	25 12·5	25 40	26 7·5	26 35	27 2·5	27 30	27 57·5
30	15	24 22·5	24 50·6	25 18·7	25 46·9	26 15	26 43·1	27 11·2	27 39·4	28 7·5	28 35·6
23 0	30	24 55	25 23·7	25 52·5	26 21·2	26 50	27 18·7	27 47·5	28 16·2	28 45	29 13·7
30	45	25 27·5	25 56·9	26 26·2	26 55·6	27 25	27 54·4	28 23·7	28 53·1	29 22·5	29 51·9
24 0	12 0	26 0	26 30	27 0	27 30	28 0	28 30	29 0	29 30	30 0	30 30
30	15	26 32·5	27 3·1	27 33·7	28 4·4	28 35	29 5·6	29 36·2	30 6·9	30 37·5	31 8·1
25 0	30	27 5	27 36·2	28 7·5	28 38·7	29 10	29 41·2	30 12·5	30 43·7	31 15	31 46·2
30	45	27 37·5	28 9·4	28 41·2	29 13·1	29 45	30 16·9	30 48·7	31 20·6	31 52·5	32 24·4
26 0	13 0	28 10	28 42·5	29 15	29 47·5	30 20	30 52·5	31 25	31 57·5	32 30	33 2·5
30	15	28 42·5	29 5·6	29 48·7	30 21·9	30 55	31 28·1	32 1·2	32 34·4	33 7·5	33 40·6
27 0	30	29 15	29 48·7	30 22·5	30 56·2	31 30	32 3·7	32 37·5	33 11·2	33 45	34 18·7
30	45	29 47·5	30 21·9	30 56·2	31 30·6	32 5	32 39·4	33 13·7	33 48·1	34 22·5	34 56·9
28 0	14 0	30 20	30 55	31 30	32 5	32 40	33 15	33 50	34 25	35 0	35 35
30	15	30 52·5	31 28·1	32 3·7	32 39·4	33 15	33 50·6	34 26·2	35 1·9	35 37·5	36 13·1
29 0	30	31 25	32 1·2	32 37·5	33 13·7	33 50	34 26·2	35 2·5	35 38·7	36 15	36 51·2
30	45	31 57·5	32 34·4	33 11·2	33 48·1	34 25	35 1·9	35 38·7	36 15·6	36 52·5	37 29·4
30 0	15 0	32 30	33 7·5	33 45	34 22·5	35 0	35 37·5	36 15	36 52·5	37 30	38 7·5

LOGARITHMS FOR REDUCING DAILY VARIATIONS

Min. or Sec.	Hours, Degrees, or Minutes												Min. or Sec.
	0	1	2	3	4	5	6	7	8	9	10	11	
0		1·3802	1·0792	9031	7781	6812	6021	5351	4771	4260	3802	3388	0
1	3·1584	1·3730	1·0756	9007	7763	6798	6009	5341	4762	4252	3795	3382	1
2	2·8573	1·3660	1·0720	8983	7745	6784	5997	5330	4753	4244	3788	3375	2
3	2·6812	1·3590	1·0685	8959	7728	6769	5985	5320	4744	4236	3780	3368	3
4	2·5563	1·3522	1·0649	8935	7710	6755	5973	5310	4735	4228	3773	3362	4
5	2·4594	1·3454	1·0614	8912	7692	6741	5961	5300	4726	4220	3766	3355	5
6	2·3802	1·3388	1·0580	8888	7674	6726	5949	5289	4717	4212	3759	3349	6
7	2·3133	1·3323	1·0546	8865	7657	6712	5937	5279	4708	4204	3752	3342	7
8	2·2553	1·3259	1·0512	8842	7639	6698	5925	5269	4699	4196	3745	3336	8
9	2·2041	1·3195	1·0478	8819	7622	6684	5913	5259	4690	4188	3737	3329	9
10	2·1584	1·3133	1·0444	8796	7604	6670	5902	5249	4682	4180	3730	3323	10
11	2·1170	1·3071	1·0411	8773	7587	6656	5890	5239	4673	4172	3723	3316	11
12	2·0792	1·3010	1·0378	8751	7570	6642	5878	5229	4664	4164	3716	3310	12
13	2·0444	1·2950	1·0345	8728	7552	6628	5866	5219	4655	4156	3709	3303	13
14	2·0122	1·2891	1·0313	8706	7535	6614	5855	5209	4646	4148	3702	3297	14
15	1·9823	1·2833	1·0280	8683	7518	6600	5843	5199	4638	4141	3695	3291	15
16	1·9542	1·2775	1·0248	8661	7501	6587	5832	5189	4629	4133	3688	3284	16
17	1·9279	1·2719	1·0216	8639	7484	6573	5820	5179	4620	4125	3681	3278	17
18	1·9031	1·2663	1·0185	8617	7467	6559	5809	5169	4611	4117	3674	3271	18
19	1·8796	1·2607	1·0153	8595	7451	6546	5797	5159	4603	4109	3667	3265	19
20	1·8573	1·2553	1·0122	8573	7434	6532	5786	5149	4594	4102	3660	3258	20
21	1·8361	1·2499	1·0091	8552	7417	6518	5774	5139	4585	4094	3653	3252	21
22	1·8159	1·2445	1·0061	8530	7401	6505	5763	5129	4577	4086	3646	3246	22
23	1·7966	1·2393	1·0030	8509	7384	6492	5752	5120	4568	4079	3639	3239	23
24	1·7782	1·2341	1·0000	8487	7368	6478	5740	5110	4559	4071	3632	3233	24
25	1·7604	1·2289	0·9970	8466	7351	6465	5729	5100	4551	4063	3625	3227	25
26	1·7434	1·2239	0·9940	8445	7335	6452	5718	5090	4542	4055	3618	3220	26
27	1·7270	1·2188	0·9910	8424	7318	6438	5706	5081	4534	4048	3611	3214	27
28	1·7112	1·2139	0·9881	8403	7302	6425	5695	5071	4525	4040	3604	3208	28
29	1·6960	1·2090	0·9852	8382	7286	6412	5684	5061	4516	4032	3597	3201	29
30	1·6812	1·2041	0·9823	8361	7270	6398	5673	5051	4508	4025	3590	3195	30
31	1·6670	1·1993	0·9794	8341	7254	6385	5662	5042	4499	4017	3583	3189	31
32	1·6532	1·1946	0·9765	8320	7238	6372	5651	5032	4491	4010	3576	3183	32
33	1·6398	1·1899	0·9737	8300	7222	6359	5640	5023	4482	4002	3570	3176	33
34	1·6269	1·1852	0·9708	8279	7206	6346	5629	5013	4474	3994	3563	3170	34
35	1·6143	1·1806	0·9680	8259	7190	6333	5618	5003	4466	3987	3556	3164	35
36	1·6021	1·1761	0·9652	8239	7174	6320	5607	4994	4457	3979	3549	3157	36
37	1·5902	1·1716	0·9625	8219	7159	6307	5596	4984	4449	3972	3542	3151	37
38	1·5786	1·1671	0·9597	8199	7143	6294	5585	4975	4440	3964	3535	3145	38
39	1·5673	1·1627	0·9570	8179	7128	6282	5574	4965	4432	3957	3529	3139	39
40	1·5563	1·1584	0·9542	8159	7112	6269	5563	4956	4424	3949	3522	3133	40
41	1·5456	1·1540	0·9515	8140	7097	6256	5552	4947	4415	3942	3515	3126	41
42	1·5351	1·1498	0·9488	8120	7081	6243	5541	4937	4407	3934	3508	3120	42
43	1·5249	1·1455	0·9462	8101	7066	6231	5531	4928	4399	3927	3301	3114	43
44	1·5149	1·1413	0·9435	8081	7050	6218	5520	4918	4390	3919	3495	3108	44
45	1·5051	1·1372	0·9408	8062	7035	6205	5509	4909	4382	3912	3488	3102	45
46	1·4956	1·1331	0·9382	8043	7020	6193	5498	4900	4374	3905	3481	3096	46
47	1·4863	1·1290	0·9356	8023	7005	6180	5488	4890	4365	3897	3475	3089	47
48	1·4771	1·1249	0·9330	8004	6990	6168	5477	4881	4357	3890	3468	3083	48
49	1·4682	1·1209	0·9305	7985	6975	6155	5466	4872	4349	3882	3461	3077	49
50	1·4594	1·1170	0·9279	7966	6960	6143	5456	4863	4341	3875	3454	3071	50
51	1·4508	1·1130	0·9254	7947	6945	6131	5445	4853	4333	3868	3448	3065	51
52	1·4424	1·1091	0·9228	7929	6930	6118	5435	4844	4324	3860	3441	3059	52
53	1·4341	1·1053	0·9203	7910	6915	6106	5424	4835	4316	3853	3434	3053	53
54	1·4260	1·1015	0·9178	7891	6900	6094	5414	4826	4308	3846	3428	3047	54
55	1·4180	1·0977	0·9153	7873	6885	6081	5403	4817	4300	3838	3421	3041	55
56	1·4102	1·0940	0·9128	7854	6871	6069	5393	4808	4292	3831	3415	3034	56
57	1·4025	1·0902	0·9104	7836	6856	6057	5382	4798	4284	3824	3408	3028	57
58	1·3949	1·0865	0·9079	7818	6841	6045	5372	4789	4276	3817	3401	3022	58
59	1·3875	1·0828	0·9055	7800	6827	6033	5361	4780	4268	3809	3395	3016	59
60	1·3802	1·0792	0·9031	7781	6812	6021	5351	4771	4260	3802	3388	3010	60
	0	1	2	3	4	5	6	7	8	9	10	11	

LOGARITHMS FOR REDUCING DAILY VARIATIONS

Min or Sec.	12	13	14	15	16	17	18	19	20	21	22	23	Min. or Sec.
	Hours, Degrees, or Minutes												
0	3010	2663	2341	2041	1761	1498	1249	1015	0792	0580	0378	0185	0
1	3004	2657	2336	2036	1756	1493	1245	1011	0788	0576	0375	0182	1
2	2998	2652	2330	2031	1752	1489	1241	1007	0785	0573	0371	0179	2
3	2992	2646	2325	2027	1747	1485	1237	1003	0781	0570	0368	0175	3
4	2986	2640	2320	2022	1743	1481	1233	0999	0777	0566	0365	0172	4
5	2980	2635	2315	2017	1738	1476	1229	0996	0774	0563	0361	0169	5
6	2974	2629	2310	2012	1734	1472	1225	0992	0770	0559	0358	0166	6
7	2968	2624	2305	2008	1729	1468	1221	0988	0767	0556	0355	0163	7
8	2962	2618	2300	2003	1725	1464	1217	0984	0763	0552	0352	0160	8
9	2956	2613	2295	1998	1720	1459	1213	0980	0759	0549	0348	0157	9
10	2950	2607	2289	1993	1716	1455	1209	0977	0756	0546	0345	0153	10
11	2944	2602	2284	1988	1711	1451	1205	0973	0753	0542	0342	0150	11
12	2938	2596	2279	1984	1707	1447	1201	0969	0749	0539	0339	0147	12
13	2933	2591	2274	1979	1702	1443	1197	0965	0745	0535	0335	0144	13
14	2927	2585	2269	1974	1698	1438	1193	0962	0741	0532	0332	0141	14
15	2921	2580	2264	1969	1694	1434	1189	0958	0738	0528	0329	0138	15
16	2915	2574	2259	1965	1689	1430	1185	0954	0734	0525	0326	0135	16
17	2909	2569	2254	1960	1685	1426	1181	0950	0731	0522	0322	0132	17
18	2903	2564	2249	1955	1680	1422	1178	0947	0727	0518	0319	0128	18
19	2897	2558	2244	1950	1676	1417	1174	0943	0724	0515	0316	0125	19
20	2891	2553	2239	1946	1671	1413	1170	0939	0720	0511	0313	0122	20
21	2885	2547	2234	1941	1667	1409	1166	0935	0716	0508	0309	0119	21
22	2880	2542	2229	1936	1662	1405	1162	0932	0713	0505	0306	0116	22
23	2874	2536	2223	1932	1658	1401	1158	0928	0709	0501	0303	0113	23
24	2868	2531	2218	1927	1654	1397	1154	0924	0706	0498	0300	0110	24
25	2862	2526	2213	1922	1649	1392	1150	0920	0702	0495	0296	0107	25
26	2856	2520	2208	1917	1645	1388	1146	0917	0699	0491	0293	0104	26
27	2850	2515	2203	1913	1640	1384	1142	0913	0695	0488	0290	0101	27
28	2845	2510	2198	1908	1636	1380	1138	0909	0692	0484	0287	0098	28
29	2839	2504	2193	1903	1632	1376	1134	0905	0688	0481	0283	0094	29
30	2833	2499	2188	1899	1627	1372	1130	0902	0685	0478	0280	0091	30
31	2827	2493	2183	1894	1623	1368	1126	0898	0681	0474	0277	0088	31
32	2821	2488	2178	1889	1618	1363	1123	0895	0677	0471	0274	0085	32
33	2816	2483	2173	1885	1614	1359	1119	0891	0674	0468	0271	0082	33
34	2810	2477	2168	1880	1610	1355	1115	0887	0670	0464	0267	0079	34
35	2804	2472	2163	1875	1605	1351	1111	0883	0667	0461	0264	0076	35
36	2798	2467	2159	1871	1601	1347	1107	0880	0663	0458	0261	0073	36
37	2793	2461	2154	1866	1597	1343	1103	0876	0660	0454	0258	0070	37
38	2787	2456	2149	1862	1592	1339	1099	0872	0656	0451	0255	0067	38
39	2781	2451	2144	1857	1588	1335	1095	0868	0653	0447	0251	0064	39
40	2775	2445	2139	1852	1584	1331	1091	0865	0649	0444	0248	0061	40
41	2770	2440	2134	1848	1579	1326	1088	0861	0646	0441	0245	0058	41
42	2764	2435	2129	1843	1575	1322	1084	0858	0642	0438	0242	0055	42
43	2758	2430	2124	1838	1571	1318	1080	0854	0639	0434	0239	0052	43
44	2753	2424	2119	1834	1566	1314	1076	0850	0635	0431	0235	0048	44
45	2747	2419	2114	1829	1562	1310	1072	0846	0632	0427	0232	0045	45
46	2741	2414	2109	1825	1558	1306	1068	0843	0628	0424	0229	0042	46
47	2736	2409	2104	1820	1553	1302	1064	0839	0625	0421	0226	0039	47
48	2730	2403	2099	1816	1549	1298	1060	0835	0621	0418	0223	0036	48
49	2724	2398	2095	1811	1545	1294	1057	0832	0618	0414	0220	0033	49
50	2719	2393	2090	1806	1540	1290	1053	0828	0614	0411	0216	0030	50
51	2713	2388	2085	1802	1536	1286	1049	0824	0611	0408	0213	0027	51
52	2707	2382	2080	1797	1532	1282	1045	0821	0608	0404	0210	0024	52
53	2702	2377	2075	1793	1527	1278	1041	0817	0604	0401	0207	0021	53
54	2696	2372	2070	1788	1523	1274	1037	0814	0601	0398	0204	0018	54
55	2690	2367	2065	1784	1519	1270	1034	0810	0597	0394	0201	0015	55
56	2685	2362	2061	1779	1515	1265	1030	0806	0594	0391	0197	0012	56
57	2679	2356	2056	1774	1510	1261	1026	0803	0590	0388	0194	0009	57
58	2674	2351	2051	1770	1506	1257	1022	0799	0587	0384	0191	0006	58
59	2668	2346	2046	1765	1502	1253	1018	0795	0583	0381	0188	0003	59
60	2663	2341	2041	1761	1498	1249	1015	0792	0580	0378	0185	0000	60
	12	13	14	15	16	17	18	19	20	21	22	23	

FOR REDUCING THE MOON'S DECLINATION

M	Difference for 10ᵐ												
	10″	20″	30″	40″	50″	60″	70″	80″	90″	100″	110″	120″	130″
1	0′ 1″	0′ 2″	0′ 3″	0′ 4″	0′ 5″	0′ 6″	0′ 7″	0′ 8″	0′ 9″	0′ 10″	0′ 11″	0′ 12″	0′ 13″
2	0 2	0 4	0 6	0 8	0 10	0 12	0 14	0 16	0 18	0 20	0 22	0 24	0 26
3	0 3	0 6	0 9	0 12	0 15	0 18	0 21	0 24	0 27	0 30	0 33	0 36	0 39
4	0 4	0 8	0 12	0 16	0 20	0 24	0 28	0 32	0 36	0 40	0 44	0 48	0 52
5	0 5	0 10	0 15	0 20	0 25	0 30	0 35	0 40	0 45	0 50	0 55	1 0	1 5
6	0 6	0 12	0 18	0 24	0 30	0 36	0 42	0 48	0 54	1 0	1 6	1 12	1 18
7	0 7	0 14	0 21	0 28	0 35	0 42	0 49	0 56	1 3	1 10	1 17	1 24	1 31
8	0 8	0 16	0 24	0 32	0 40	0 48	0 56	1 4	1 12	1 20	1 28	1 36	1 44
9	0 9	0 18	0 27	0 36	0 45	0 54	1 3	1 12	1 21	1 30	1 39	1 48	1 57
10	0 10	0 20	0 30	0 40	0 50	1 0	1 10	1 20	1 30	1 40	1 50	2 0	2 10
11	0 11	0 22	0 33	0 44	0 55	1 6	1 17	1 28	1 39	1 50	2 1	2 12	2 23
12	0 12	0 24	0 36	0 48	1 0	1 12	1 24	1 36	1 48	2 0	2 12	2 24	2 36
13	0 13	0 26	0 39	0 52	1 5	1 18	1 31	1 44	1 57	2 10	2 23	2 36	2 49
14	0 14	0 28	0 42	0 56	1 10	1 24	1 38	1 52	2 6	2 20	2 34	2 48	3 2
15	0 15	0 30	0 45	1 0	1 15	1 30	1 45	2 0	2 15	2 30	2 45	3 0	3 15
16	0 16	0 32	0 48	1 4	1 20	1 36	1 52	2 8	2 24	2 40	2 56	3 12	3 28
17	0 17	0 34	0 51	1 8	1 25	1 42	1 59	2 16	2 33	2 50	3 7	3 24	3 41
18	0 18	0 36	0 54	1 12	1 30	1 48	2 6	2 24	2 42	3 0	3 18	3 36	3 54
19	0 19	0 38	0 57	1 16	1 35	1 54	2 13	2 32	2 51	3 10	3 29	3 48	4 7
20	0 20	0 40	1 0	1 20	1 40	2 0	2 20	2 40	3 0	3 20	3 40	4 0	4 20
21	0 21	0 42	1 3	1 24	1 45	2 6	2 27	2 48	3 9	3 30	3 51	4 12	4 33
22	0 22	0 44	1 6	1 28	1 50	2 12	2 34	2 56	3 18	3 40	4 2	4 24	4 46
23	0 23	0 46	1 9	1 32	1 55	2 18	2 41	3 4	3 27	3 50	4 13	4 36	4 59
24	0 24	0 48	1 12	1 36	2 0	2 24	2 48	3 12	3 36	4 0	4 24	4 48	5 12
25	0 25	0 50	1 15	1 40	2 5	2 30	2 55	3 20	3 45	4 10	4 35	5 0	5 25
26	0 26	0 52	1 18	1 44	2 10	2 36	3 2	3 28	3 54	4 20	4 46	5 12	5 38
27	0 27	0 54	1 21	1 48	2 15	2 42	3 9	3 36	4 3	4 30	4 57	5 24	5 51
28	0 28	0 56	1 24	1 52	2 20	2 48	3 16	3 44	4 12	4 40	5 8	5 36	6 4
29	0 29	0 58	1 27	1 56	2 25	2 54	3 23	3 52	4 21	4 50	5 19	5 48	6 17
30	0 30	1 0	1 30	2 0	2 30	3 0	3 30	4 0	4 30	5 0	5 30	6 0	6 30
31	0 31	1 2	1 33	2 4	2 35	3 6	3 37	4 8	4 39	5 10	5 41	6 12	6 43
32	0 32	1 4	1 36	2 8	2 40	3 12	3 44	4 16	4 48	5 20	5 52	6 24	6 56
33	0 33	1 6	1 39	2 12	2 45	3 18	3 51	4 24	4 57	5 30	6 3	6 36	7 9
34	0 34	1 8	1 42	2 16	2 50	3 24	3 58	4 32	5 6	5 40	6 14	6 48	7 22
35	0 35	1 10	1 45	2 20	2 55	3 30	4 5	4 40	5 15	5 50	6 25	7 0	7 35
36	0 36	1 12	1 48	2 24	3 0	3 36	4 12	4 48	5 24	6 0	6 36	7 12	7 48
37	0 37	1 14	1 51	2 28	3 5	3 42	4 19	4 56	5 33	6 10	6 47	7 24	8 1
38	0 38	1 16	1 54	2 32	3 10	3 48	4 26	5 4	5 42	6 20	6 58	7 36	8 14
39	0 39	1 18	1 57	2 36	3 15	3 54	4 33	5 12	5 51	6 30	7 9	7 48	8 27
40	0 40	1 20	2 0	2 40	3 20	4 0	4 40	5 20	6 0	6 40	7 20	8 0	8 40
41	0 41	1 22	2 3	2 44	3 25	4 6	4 47	5 28	6 9	6 50	7 31	8 12	8 53
42	0 42	1 24	2 6	2 48	3 30	4 12	4 54	5 36	6 18	7 0	7 42	8 24	9 6
43	0 43	1 26	2 9	2 52	3 35	4 18	5 1	5 44	6 27	7 10	7 53	8 36	9 19
44	0 44	1 28	2 12	2 56	3 40	4 24	5 8	5 52	6 36	7 20	8 4	8 48	9 32
45	0 45	1 30	2 15	3 0	3 45	4 30	5 15	6 0	6 45	7 30	8 15	9 0	9 45
46	0 46	1 32	2 18	3 4	3 50	4 36	5 22	6 8	6 54	7 40	8 26	9 12	9 58
47	0 47	1 34	2 21	3 8	3 55	4 42	5 29	6 16	7 3	7 50	8 37	9 24	10 11
48	0 48	1 36	2 24	3 12	4 0	4 48	5 36	6 24	7 12	8 0	8 48	9 36	10 24
49	0 49	1 38	2 27	3 16	4 5	4 54	5 43	6 32	7 21	8 10	8 59	9 48	10 37
50	0 50	1 40	2 30	3 20	4 10	5 0	5 50	6 40	7 30	8 20	9 10	10 0	10 50
51	0 51	1 42	2 33	3 24	4 15	5 6	5 57	6 48	7 39	8 30	9 21	10 12	11 3
52	0 52	1 44	2 36	3 28	4 20	5 12	6 4	6 56	7 48	8 40	9 32	10 24	11 16
53	0 53	1 46	2 39	3 32	4 25	5 18	6 11	7 4	7 57	8 50	9 43	10 36	11 29
54	0 54	1 48	2 42	3 36	4 30	5 24	6 18	7 12	8 6	9 0	9 54	10 48	11 42
55	0 55	1 50	2 45	3 40	4 35	5 30	6 25	7 20	8 15	9 10	10 5	11 0	11 55
56	0 56	1 52	2 48	3 44	4 40	5 36	6 32	7 28	8 24	9 20	10 16	11 12	12 8
57	0 57	1 54	2 51	3 48	4 45	5 42	6 39	7 36	8 33	9 30	10 27	11 24	12 21
58	0 58	1 56	2 54	3 52	4 50	5 48	6 46	7 44	8 42	9 40	10 38	11 36	12 34
59	0 59	1 58	2 57	3 56	4 55	5 54	6 53	7 52	8 51	9 50	10 49	11 48	12 47
60	1 0	2 0	3 0	4 0	5 0	6 0	7 0	8 0	9 0	10 0	11 0	12 0	13 0

FOR REDUCING THE MOON'S DECLINATION

M	Difference for 10^m													
	140″	150″	160″	170″	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″
1	0′ 14″	0′ 15″	0′ 16″	0′ 17″	0″·1	0″·2	0″·3	0″·4	0″·5	0″·6	0″·7	0″·8	0″·9	1″
2	0 28	0 30	0 32	0 34	0·2	·4	·6	·8	1·0	1·2	1·4	1·6	1·8	2
3	0 42	0 45	0 48	0 51	0·3	·6	·9	1·2	1·5	1·8	2·1	2·4	2·7	3
4	0 56	1 0	1 4	1 8	0·4	·8	1·2	1·6	2·0	2·4	2·8	3·2	3·6	4
5	1 10	1 15	1 20	1 25	0·5	1·0	1·5	2·0	2·5	3·0	3·5	4·0	4·5	5
6	1 24	1 30	1 36	1 42	0·6	1·2	1·8	2·4	3·0	3·6	4·2	4·8	5·4	6
7	1 38	1 45	1 52	1 59	0·7	1·4	2·1	2·8	3·5	4·2	4·9	5·6	6·3	7
8	1 52	2 0	2 8	2 16	0·8	1·6	2·4	3·2	4·0	4·8	5·6	6·4	7·2	8
9	2 6	2 15	2 24	2 33	0·9	1·8	2·7	3·6	4·5	5·4	6·3	7·2	8·1	9
10	2 20	2 30	2 40	2 50	1·0	2·0	3·0	4·0	5·0	6·0	7·0	8·0	9·0	10
11	2 34	2 45	2 56	3 7	1·1	2·2	3·3	4·4	5·5	6·6	7·7	8·8	9·9	11
12	2 48	3 0	3 12	3 24	1·2	2·4	3·6	4·8	6·0	7·2	8·4	9·6	10·8	12
13	3 2	3 15	3 28	3 41	1·3	2·6	3·9	5·2	6·5	7·8	9·1	10·4	11·7	13
14	3 16	3 30	3 44	3 58	1·4	2·8	4·2	5·6	7·0	8·4	9·8	11·2	12·6	14
15	3 30	3 45	4 0	4 15	1·5	3·0	4·5	6·0	7·5	9·0	10·5	12·0	13·5	15
16	3 44	4 0	4 16	4 32	1·6	3·2	4·8	6·4	8·0	9·6	11·2	12·8	14·4	16
17	3 58	4 15	4 32	4 49	1·7	3·4	5·1	6·8	8·5	10·2	11·9	13·6	15·3	17
18	4 12	4 30	4 48	5 6	1·8	3·6	5·4	7·2	9·0	10·8	12·6	14·4	16·2	18
19	4 26	4 45	5 4	5 23	1·9	3·8	5·7	7·6	9·5	11·4	13·3	15·2	17·1	19
20	4 40	5 0	5 20	5 40	2·0	4·0	6·0	8·0	10·0	12·0	14·0	16·0	18·0	20
21	4 54	5 15	5 36	5 57	2·1	4·2	6·3	8·4	10·5	12·6	14·7	16·8	18·9	21
22	5 8	5 30	5 52	6 14	2·2	4·4	6·6	8·8	11·0	13·2	15·4	17·6	19·8	22
23	5 22	5 45	6 8	6 31	2·3	4·6	6·9	9·2	11·5	13·8	16·1	18·4	20·7	23
24	5 36	6 0	6 24	6 48	2·4	4·8	7·2	9·6	12·0	14·4	16·8	19·2	21·6	24
25	5 50	6 15	6 40	7 5	2·5	5·0	7·5	10·0	12·5	15·0	17·5	20·0	22·5	25
26	6 4	6 30	6 56	7 22	2·6	5·2	7·8	10·4	13·0	15·6	18·2	20·8	23·4	26
27	6 18	6 45	7 12	7 39	2·7	5·4	8·1	10·8	13·5	16·2	18·9	21·6	24·3	27
28	6 32	7 0	7 28	7 56	2·8	5·6	8·4	11·2	14·0	16·8	19·6	22·4	25·2	28
29	6 46	7 15	7 44	8 13	2·9	5·8	8·7	11·6	14·5	17·4	20·3	23·2	26·1	29
30	7 0	7 30	8 0	8 30	3·0	6·0	9·0	12·0	15·0	18·0	21·0	24·0	27·0	30
31	7 14	7 45	8 16	8 47	3·1	6·2	9·3	12·4	15·5	18·6	21·7	24·8	27·9	31
32	7 28	8 0	8 32	9 4	3·2	6·4	9·6	12·8	16·0	19·2	22·4	25·6	28·8	32
33	7 42	8 15	8 48	9 21	3·3	6·6	9·9	13·2	16·5	19·8	23·1	26·4	29·7	33
34	7 56	8 30	9 4	9 38	3·4	6·8	10·2	13·6	17·0	20·4	23·8	27·2	30·6	34
35	8 10	8 45	9 20	9 55	3·5	7·0	10·5	14·0	17·5	21·0	24·5	28·0	31·5	35
36	8 24	9 0	9 36	10 12	3·6	7·2	10·8	14·4	18·0	21·6	25·2	28·8	32·4	36
37	8 38	9 15	9 52	10 29	3·7	7·4	11·1	14·8	18·5	22·2	25·9	29·6	33·3	37
38	8 52	9 30	10 8	10 46	3·8	7·6	11·4	15·2	19·0	22·8	26·6	30·4	34·2	38
39	9 6	9 45	10 24	11 3	3·9	7·8	11·7	15·6	19·5	23·4	27·3	31·2	35·1	39
40	9 20	10 0	10 40	11 20	4·0	8·0	12·0	16·0	20·0	24·0	28·0	32·0	36·0	40
41	9 34	10 15	10 56	11 37	4·1	8·2	12·3	16·4	20·5	24·6	28·7	32·8	36·9	41
42	9 48	10 30	11 12	11 54	4·2	8·4	12·6	16·8	21·0	25·2	29·4	33·6	37·8	42
43	10 2	10 45	11 28	12 11	4·3	8·6	12·9	17·2	21·5	25·8	30·1	34·4	38·7	43
44	10 16	11 0	11 44	12 28	4·4	8·8	13·2	17·6	22·0	26·4	30·8	35·2	39·6	44
45	10 30	11 15	12 0	12 45	4·5	9·0	13·5	18·0	22·5	27·0	31·5	36·0	40·5	45
46	10 44	11 30	12 16	13 2	4·6	9·2	13·8	18·4	23·0	27·6	32·2	36·8	41·4	46
47	10 58	11 45	12 32	13 19	4·7	9·4	14·1	18·8	23·5	28·2	32·9	37·6	42·3	47
48	11 12	12 0	12 48	13 36	4·8	9·6	14·4	19·2	24·0	28·8	33·6	38·4	43·2	48
49	11 26	12 15	13 4	13 53	4·9	9·8	14·7	19·6	24·5	29·4	34·3	39·2	44·1	49
50	11 40	12 30	13 20	14 10	5·0	10·0	15·0	20·0	25·0	30·0	35·0	40·0	45·0	50
51	11 54	12 45	13 36	14 27	5·1	10·2	15·3	20·4	25·5	30·6	35·7	40·8	45·9	51
52	12 8	13 0	13 52	14 44	5·2	10·4	15·6	20·8	26·0	31·2	36·4	41·6	46·8	52
53	12 22	13 15	14 8	15 1	5·3	10·6	15·9	21·2	26·5	31·8	37·1	42·4	47·7	53
54	12 36	13 30	14 24	15 18	5·4	10·8	16·2	21·6	27·0	32·4	37·8	43·2	48·6	54
55	12 50	13 45	14 40	15 35	5·5	11·0	16·5	22·0	27·5	33·0	38·5	44·0	49·5	55
56	13 4	14 0	14 56	15 52	5·6	11·2	16·8	22·4	28·0	33·6	39·2	44·8	50·4	56
57	13 18	14 15	15 12	16 9	5·7	11·4	17·1	22·8	28·5	34·2	39·9	45·6	51·3	57
58	13 32	14 30	15 28	16 26	5·8	11·6	17·4	23·2	29·0	34·8	40·6	46·4	52·2	58
59	13 46	14 45	15 44	16 43	5·9	11·8	17·7	23·6	29·5	35·4	41·3	47·2	53·1	59
60	14 0	15 0	16 0	17 0	6·0	12·0	18·0	24·0	30·0	36·0	42·0	48·0	54·0	60

TABLE 23

ACCELERATION

H	M	S	M	S	S	Dec.
1	0	9·86	1	0·16	1	·00
2	0	19·71	2	0·33	2	·00
3	0	29·57	3	0·49	3	·01
4	0	39·43	4	0·66	4	·01
5	0	49·28	5	0·82	5	·01
6	0	59·14	6	0·98	6	·02
7	1	9·00	7	1·15	7	·02
8	1	18·85	8	1·31	8	·02
9	1	28·71	9	1·48	9	·02
10	1	38·56	10	1·64	10	·03
11	1	48·42	11	1·81	11	·03
12	1	58·28	12	1·97	12	·03
13	2	8·13	13	2·13	13	·04
14	2	17·99	14	2·30	14	·04
15	2	27·85	15	2·46	15	·04
16	2	37·70	16	2·63	16	·04
17	2	47·56	17	2·79	17	·05
18	2	57·42	18	2·96	18	·05
19	3	7·27	19	3·12	19	·05
20	3	17·13	20	3·29	20	·05
21	3	26·99	21	3·45	21	·06
22	3	36·84	22	3·61	22	·06
23	3	46·70	23	3·78	23	·06
24	3	56·56	24	3·94	24	·07
			25	4·11	25	·07
			26	4·27	26	·07
			27	4·44	27	·07
			28	4·60	28	·08
			29	4·76	29	·08
			30	4·93	30	·08
			31	5·09	31	·08
			32	5·26	32	·09
			33	5·42	33	·09
			34	5·59	34	·09
			35	5·75	35	·10
			36	5·91	36	·10
			37	6·08	37	·10
			38	6·24	38	·11
			39	6·40	39	·11
			40	6·57	40	·11
			41	6·74	41	·11
			42	6·90	42	·12
			43	7·06	43	·12
			44	7·23	44	·12
			45	7·39	45	·12
			46	7·56	46	·13
			47	7·72	47	·13
			48	7·89	48	·13
			49	8·05	49	·14
			50	8·21	50	·14
			51	8·38	51	·14
			52	8·54	52	·14
			53	8·71	53	·15
			54	8·87	54	·15
			55	9·04	55	·15
			56	9·20	56	·15
			57	9·36	57	·16
			58	9·53	58	·16
			59	9·69	59	·16
			60	9·86	60	·16

TABLE 24

RETARDATION

H	M	S	M	S	S	Dec.
1	0	9·83	1	0·16	1	·00
2	0	19·66	2	0·33	2	·00
3	0	29·49	3	0·49	3	·01
4	0	39·32	4	0·66	4	·01
5	0	49·15	5	0·82	5	·01
6	0	58·98	6	0·98	6	·02
7	1	8·81	7	1·15	7	·02
8	1	18·64	8	1·31	8	·02
9	1	28·47	9	1·47	9	·02
10	1	38·30	10	1·64	10	·03
11	1	48·13	11	1·80	11	·03
12	1	57·95	12	1·97	12	·03
13	2	7·78	13	2·13	13	·04
14	2	17·61	14	2·29	14	·04
15	2	27·44	15	2·46	15	·04
16	2	37·27	16	2·62	16	·04
17	2	47·10	17	2·78	17	·05
18	2	56·93	18	2·95	18	·05
19	3	6·76	19	3·11	19	·05
20	3	16·59	20	3·28	20	·05
21	3	26·42	21	3·44	21	·06
22	3	36·25	22	3·60	22	·06
23	3	46·08	23	3·77	23	·06
24	3	55·91	24	3·93	24	·07
			25	4·10	25	·07
			26	4·26	26	·07
			27	4·42	27	·07
			28	4·59	28	·08
			29	4·75	29	·08
			30	4·91	30	·08
			31	5·08	31	·08
			32	5·24	32	·09
			33	5·41	33	·09
			34	5·57	34	·09
			35	5·73	35	·10
			36	5·90	36	·10
			37	6·06	37	·10
			38	6·23	38	·11
			39	6·39	39	·11
			40	6·55	40	·11
			41	6·72	41	·11
			42	6·88	42	·12
			43	7·04	43	·12
			44	7·21	44	·12
			45	7·37	45	·12
			46	7·54	46	·13
			47	7·70	47	·13
			48	7·86	48	·13
			49	8·03	49	·14
			50	8·19	50	·14
			51	8·36	51	·14
			52	8·52	52	·14
			53	8·68	53	·15
			54	8·85	54	·15
			55	9·01	55	·15
			56	9·17	56	·15
			57	9·34	57	·16
			58	9·50	58	·16
			59	9·67	59	·16
			60	9·83	60	·16

FOR FINDING THE EQUATION OF SECOND DIFFERENCES

Tabular Interval								Multiplier.	Logarit.
24 Hours		12 Hours		3 Hours		1 Hour			
$0^{h}12^{m}$	$23^{h}48^{m}$	$0^{h}\ 6^{m}$	$11^{h}54^{m}$	$0^{h}\ 1^{m}{\cdot}5$	$2^{h}58^{m}{\cdot}5$			·0041	7·61615
0 24	23 36	0 12	11 48	0 3	2 57	1^{m}	59^{m}	·0082	7·91352
0 36	23 24	0 18	11 42	0 4·5	2 55·5			·0122	8·08591
0 48	23 12	0 24	11 36	0 6	2 54	2	58	·0161	8·20713
1 0	23 0	0 30	11 30	0 7·5	2 52·5			·0200	8·30028
1 12	22 48	0 36	11 24	0 9	2 51	3	57	·0238	8·37566
1 24	22 36	0 42	11 18	0 10·5	2 49·5			·0275	8·43878
1 36	22 24	0 48	11 12	0 12	2 48	4	56	·0311	8·49292
1 48	22 12	0 54	11 6	0 13 5	2 46·5			·0347	8·54017
2 0	22 0	1 0	11 0	0 15	2 45	5	55	·0382	8·58200
2 12	21 48	1 6	10 54	0 16·5	2 43·5			·0416	8·61943
2 24	21 36	1 12	10 48	0 18	2 42	6	54	·0450	8·65321
2 36	21 24	1 18	10 42	0 19·5	2 40·5			·0483	8·68393
2 48	21 12	1 24	10 36	0 21	2 39	7	53	·0515	8·71204
3 0	21 0	1 30	10 30	0 22·5	2 37·5			·0547	8·73789
3 12	21 48	1 36	10 24	0 24	2 36	8	52	·0578	8·76176
3 24	20 36	1 42	10 18	0 25·5	2 34·5			·0608	8·78389
3 36	20 24	1 48	10 12	0 27	2 33	9	51	·0637	8·80448
3 48	20 12	1 54	10 6	0 28·5	2 31·5			·0666	8·82368
4 0	20 0	2 0	10 6	0 30	2 80	10	50	·0694	8·84164
4 12	19 48	2 6	9 54	0 31·5	2 28·5			·0722	8·85846
4 24	19 36	2 12	9 48	0 33	2 27	11	49	·0749	8·87426
4 36	19 24	2 18	9 42	0 34·5	2 25·5			·0775	8·88911
4 48	19 12	2 24	9 36	0 36	2 24	12	48	·0800	8·90309
5 0	19 0	2 30	9 30	0 37·5	2 22·5			·0825	8 91627
5 12	18 48	2 36	9 24	0 39	2 21	13	47	·0849	8·92871
5 24	18 36	2 42	9 18	0 40·5	2 19·5			·0872	8·94045
5 36	18 24	2 48	9 12	0 42	2 18	14	46	·0894	8·95195
5 48	18 12	2 54	9 6	0 43·5	2 16·5			·0916	8·96205
6 0	18 0	3 0	9 0	0 45	2 15	15	45	·0937	8·97197
6 12	17 48	3 6	8 54	0 46·5	2 13·5			·0958	8·98136
6 24	17 36	3 12	8 48	0 48	2 12	16	44	·0978	8·99024
6 36	17 24	3 18	8 42	0 49·5	2 10·5			·0997	8·99864
6 48	17 12	3 24	8 36	0 51	2 9	17	43	·1015	9·00658
7 0	17 0	3 30	8 30	0 52·5	2 7·5			·1033	9·01409
7 12	16 48	3 36	8 24	0 54	2 6	18	42	·1050	9·02119
7 24	16 36	3 42	8 18	0 55·5	2 4·5			·1066	9·02789
7 36	16 24	3 48	8 12	0 57	2 3	19	41	·1082	9·03421
7 48	16 12	3 54	8 6	0 58·5	2 1·5			·1097	9·04016
8 0	16 0	4 0	8 0	1 0	2 0	20	40	·1111	9·04576
8 12	15 48	4 6	7 54	1 1·5	1 58·5			·1125	9·05102
8 24	15 36	4 12	7 48	1 3	1 57	21	39	·1138	9·05595
8 36	15 24	4 18	7 42	1 4·5	1 55·5			·1150	9 06057
8 48	15 12	4 24	7 36	1 6	1 54	22	38	·1161	9·06487
9 0	15 0	4 30	7 30	1 7·5	1 52·5			·1172	9·06888
9 12	14 48	4 36	7 24	1 9	1 51	23	37	·1182	9·07260
9 24	14 36	4 42	7 18	1 10·5	1 49·5			·1191	9·07603
9 36	14 24	4 48	7 12	1 12	1 48	24	36	·1200	9·07918
9 48	14 12	4 54	7 6	1 13·5	1 46·5			·1208	9·08206
10 0	14 0	5 0	7 0	1 15	1 45	25	35	·1215	9·08468
10 12	13 48	5 6	6 54	1 16·5	1 43 5			·1222	9·08703
10 24	13 36	5 12	6 48	1 18	1 42	26	34	·1228	9·08912
10 36	13 24	5 18	6 42	1 19·5	1 40·5			·1233	9·09096
10 48	13 12	5 24	6 36	1 21	1 39	27	33	·1237	9·09255
11 0	13 0	5 30	6 30	1 22·5	1 37·5			·1241	9·09388
11 12	12 48	5 36	6 24	1 24	1 36	28	32	·1244	9·09498
11 24	12 36	5 42	6 18	1 25·5	1 34·5			·1247	9·09582
11 36	12 24	5 48	6 12	1 27	1 33	29	31	·1249	9·09643
11 48	12 12	5 51	6 6	1 28·5	1 31·5			·1250	9·09679
12 0	12 0	6 0	6 0	1 30	1 30	30	30	·1250	9·09691

APPARENT TIME OF THE SUN'S RISING AND SETTING

Declination, of the *same* Name as the Latitude

Lat.	0° Ris.	0° Sett.	2° Ris.	2° Sett.	4° Ris.	4° Sett.	6° Ris.	6° Sett.	8° Ris.	8° Sett.	9° Ris.	9° Sett.	10° Ris.	10° Sett.
0°	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m
2	6 0	6 0	6 0	6 0	6 0	6 0	6 0	6 0	5 59	6 1	5 59	6 1	5 59	6 1
4	6 0	6 0	6 0	6 0	5 59	6 1	5 59	6 1	5 58	6 2	5 58	6 2	5 57	6 3
6	6 0	6 0	6 0	6 0	5 58	6 2	5 58	6 2	5 57	6 3	5 57	6 3	5 56	0 4
8	6 0	6 0	5 59	6 1	5 58	6 2	5 57	6 3	5 56	6 4	5 55	6 5	5 55	6 5
10	6 0	6 0	5 59	6 1	5 57	6 3	5 56	6 4	5 54	6 6	5 54	6 6	5 53	6 7
12	5 0	6 0	5 58	6 2	5 57	6 3	5 55	6 5	5 53	6 7	5 53	6 7	5 52	6 9
14	6 0	6 0	5 58	6 2	5 56	6 4	5 54	6 6	5 52	6 8	5 51	6 8	5 51	6 10
16	6 0	6 0	5 58	6 2	5 55	6 5	5 53	6 7	5 51	6 9	5 50	6 10	5 48	6 12
18	6 0	6 0	5 58	6 2	5 55	6 5	5 52	6 8	5 50	6 10	5 48	6 12	5 47	6 13
20	6 0	6 0	5 57	6 3	5 54	6 6	5 51	6 9	5 48	6 12	5 47	6 13	5 45	6 15
21	6 0	6 0	5 57	6 3	5 54	6 6	5 51	6 9	5 48	6 12	5 46	6 14	5 44	6 16
22	6 0	6 0	5 57	6 3	5 54	6 6	5 50	6 10	5 47	6 13	5 45	6 15	5 44	6 16
23	6 0	6 0	5 57	6 3	5 53	6 7	5 50	6 10	5 46	6 14	5 45	6 15	5 43	6 17
24	6 0	6 0	5 57	6 3	5 53	6 7	5 49	6 11	5 46	6 14	5 44	6 16	5 42	6 18
25	6 0	6 0	5 56	6 4	5 53	6 7	5 49	6 11	5 45	6 15	5 43	6 17	5 41	6 19
26	6 0	6 0	5 56	6 4	5 52	6 8	5 48	6 12	5 44	6 16	5 42	6 18	5 40	6 20
27	6 0	6 0	5 56	6 4	5 52	6 8	5 48	6 12	5 44	6 16	5 41	6 19	5 39	6 21
28	6 0	6 0	5 56	6 4	5 51	6 9	5 47	6 13	5 43	6 17	5 41	6 19	5 38	6 22
29	6 0	6 0	5 56	6 4	5 51	6 9	5 47	6 13	5 42	6 18	5 40	6 20	5 38	6 22
30	6 0	6 0	5 55	6 5	5 51	6 9	5 46	6 14	5 41	6 19	5 39	6 21	5 37	6 23
31	6 0	6 0	5 55	6 5	5 50	6 10	5 46	6 14	5 41	6 19	5 38	6 22	5 36	6 24
32	6 0	6 0	5 55	6 5	5 50	6 10	5 45	6 15	5 40	6 20	5 37	6 23	5 35	6 25
33	6 0	6 0	5 55	6 5	5 50	6 10	5 44	6 16	5 39	6 21	5 36	6 24	5 34	6 26
34	6 0	6 0	5 55	6 5	5 49	6 11	5 44	6 16	5 38	6 22	5 35	6 25	5 33	6 27
35	6 0	6 0	5 55	6 5	5 49	6 11	5 43	6 17	5 37	6 23	5 35	6 25	5 32	6 28
36	6 0	6 0	5 55	6 5	5 48	6 12	5 42	6 18	5 37	6 23	5 34	6 26	5 31	6 29
37	6 0	6 0	5 55	6 5	5 48	6 12	5 42	6 18	5 36	6 24	5 33	6 27	5 29	6 31
38	6 0	6 0	5 55	6 5	5 47	6 13	5 41	6 19	5 35	6 25	5 32	6 29	5 28	6 32
39	6 0	6 0	5 55	6 5	5 47	6 13	5 40	6 20	5 34	6 26	5 31	6 29	5 27	6 33
40	6 0	6 0	5 54	6 6	5 47	6 13	5 40	6 20	5 33	6 27	5 29	6 31	5 26	6 34
41	6 0	6 0	5 54	6 6	5 46	6 14	5 39	6 21	5 32	6 28	5 28	6 32	5 25	6 35
42	6 0	6 0	5 54	6 6	5 46	6 14	5 38	6 22	5 31	6 29	5 27	6 33	5 23	6 37
43	6 0	6 0	5 53	6 7	5 45	6 15	5 38	6 22	5 30	6 30	5 26	6 34	5 22	6 38
44	6 0	6 0	5 53	6 7	5 45	6 15	5 37	6 23	5 29	6 31	5 25	6 35	5 21	6 39
45	6 0	6 0	5 52	6 8	5 44	6 16	5 36	6 24	5 28	6 32	5 24	6 36	5 19	6 41
46	6 0	6 0	5 52	6 8	5 43	6 17	5 35	6 25	5 27	6 33	5 22	6 38	5 18	6 42
47	6 0	6 0	5 51	6 9	5 43	6 17	5 34	6 26	5 25	6 35	5 21	6 39	5 16	6 44
48	6 0	6 0	5 51	6 9	5 42	6 18	5 33	6 27	5 24	6 36	5 19	6 41	5 15	6 45
49	6 0	6 0	5 51	6 9	5 42	6 18	5 32	6 28	5 23	6 37	5 18	6 42	5 13	6 47
50	6 0	6 0	5 50	6 10	5 41	6 19	5 31	6 29	5 21	6 39	5 16	6 44	5 11	6 49
51	6 0	6 0	5 50	6 10	5 40	6 20	5 30	6 30	5 20	6 40	5 15	6 45	5 10	6 50
52	6 0	6 0	5 50	6 10	5 39	6 21	5 29	6 31	5 19	6 41	5 13	6 47	5 8	6 52
53	6 0	6 0	5 49	6 11	5 39	6 21	5 28	6 32	5 17	6 43	5 11	6 49	5 6	6 54
54	6 0	6 0	5 49	6 11	5 38	6 22	5 27	6 33	5 15	6 45	5 10	6 50	5 4	6 56
55	6 0	6 0	5 49	6 11	5 37	6 23	5 25	6 35	5 14	6 46	5 8	6 52	5 2	6 58
56	6 0	6 0	5 48	6 12	5 36	6 24	5 24	6 36	5 12	6 48	5 6	6 54	4 59	7 1
57	6 0	6 0	5 48	6 12	5 35	6 25	5 23	6 37	5 10	6 50	5 4	6 56	4 57	7 3
58	6 0	6 0	5 47	6 13	5 34	6 26	5 21	6 39	5 8	6 52	5 1	6 59	4 54	7 6
59	6 0	6 0	5 47	6 13	5 33	6 27	5 20	6 40	5 6	6 54	4 59	7 1	4 52	7 8
60	6 0	6 0	5 46	6 14	5 32	6 28	5 18	6 42	5 4	6 56	4 56	7 4	4 49	7 11
61	6 0	6 0	5 46	6 14	5 31	6 29	5 16	6 44	5 1	6 59	4 54	7 6	4 46	7 14
62	6 0	6 0	5 45	6 15	5 30	6 30	5 14	6 46	4 59	7 1	4 51	7 9	4 43	7 17
63	6 0	6 0	5 44	6 16	5 28	6 32	5 12	6 48	4 56	7 4	4 48	7 12	4 39	7 21
64	6 0	6 0	5 44	6 16	5 27	6 33	5 10	6 50	4 53	7 7	4 44	7 16	4 35	7 25
65	6 0	6 0	5 43	6 17	5 26	6 34	5 8	6 52	4 50	7 10	4 41	7 19	4 31	7 29
66	6 0	6 0	5 42	6 18	5 24	6 35	5 5	6 54	4 46	7 13	4 37	7 23	4 27	7 33
66½	6 0	6 0	5 42	6 18	5 23	6 36	5 4	6 56	4 44	7 16	4 34	7 26	4 24	7 36
Lat.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.

Latitude and Declination of *contrary* Names

APPARENT TIMES OF THE SUN'S RISING AND SETTING

Declination, of the *same* Name as the Latitude

Lat.	11°		12°		13°		14°		15°		16°		7°	
	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.
0°	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m
2	5 59	6 1	5 58	6 1	5 58	6 2	5 58	6 2	5 58	6 2	5 58	6 2	5 58	6 2
4	5 57	6 3	5 57	6 3	5 56	6 4	5 56	6 4	5 56	6 4	5 56	6 4	5 55	6 5
6	5 56	6 4	5 55	6 5	5 55	6 5	5 54	6 6	5 54	6 6	5 53	6 7	5 53	6 7
8	5 54	6 6	5 53	6 8	5 53	6 7	5 52	6 8	5 51	6 9	5 51	6 9	5 50	6 10
10	5 52	6 8	5 52	6 9	5 51	6 9	5 50	6 10	5 49	6 11	5 49	6 12	5 48	6 12
12	5 51	6 9	5 50	6 10	5 49	6 11	5 48	6 12	5 47	6 13	5 46	6 14	5 45	6 15
14	5 50	6 11	5 48	6 12	5 48	6 13	5 46	6 14	5 45	6 15	5 44	6 16	5 43	6 17
16	5 47	6 13	5 46	6 14	5 45	6 15	5 44	6 16	5 42	6 18	5 41	6 19	5 40	6 20
18	5 46	6 14	5 44	6 16	5 43	6 17	5 41	6 19	5 40	6 20	5 39	6 21	5 37	6 23
20	5 44	6 16	5 42	6 18	5 41	6 19	5 39	6 21	5 38	6 22	5 36	6 24	5 34	6 26
21	5 43	6 17	5 41	6 19	5 40	6 20	5 38	6 22	5 36	6 24	5 35	6 25	5 33	6 27
22	5 42	6 18	5 40	6 20	5 39	6 21	5 37	6 23	5 35	6 25	5 33	6 27	5 32	6 28
23	5 41	6 19	5 39	6 21	5 38	6 22	5 36	6 24	5 34	6 26	5 32	6 28	5 30	6 30
24	5 40	6 20	5 38	6 22	5 36	6 24	5 34	6 26	5 33	6 27	5 31	6 29	5 29	6 31
25	5 39	6 21	5 37	6 23	5 35	6 25	5 33	6 27	5 31	6 29	5 29	6 31	5 27	6 33
26	5 38	6 22	5 36	6 24	5 34	6 26	5 32	6 28	5 30	6 30	5 28	6 32	5 26	6 34
27	5 37	6 23	5 35	6 25	5 33	6 27	5 31	6 29	5 29	6 31	5 26	6 34	5 24	6 36
28	5 36	6 24	5 34	6 26	5 32	6 28	5 30	6 30	5 27	6 33	5 25	6 35	5 23	6 37
29	5 35	6 25	5 33	6 27	5 31	6 29	5 28	6 32	5 26	6 34	5 23	6 37	5 21	6 39
30	5 34	6 26	5 32	6 28	5 29	6 31	5 27	6 33	5 24	6 36	5 22	6 38	5 19	6 41
31	5 33	6 27	5 31	6 29	5 28	6 32	5 26	6 34	5 23	6 37	5 20	6 40	5 18	6 42
32	5 32	6 28	5 29	6 31	5 27	6 33	5 24	6 36	5 21	6 39	5 19	6 41	5 16	6 44
33	5 31	6 29	5 28	6 32	5 26	6 34	5 23	6 37	5 20	6 40	5 17	6 43	5 14	6 46
34	5 30	6 30	5 27	6 33	5 24	6 36	5 21	6 39	5 18	6 42	5 15	6 45	5 12	6 48
35	5 29	6 31	5 26	6 34	5 23	6 37	5 20	6 40	5 17	6 43	5 14	6 46	5 11	6 49
36	5 28	6 32	5 24	6 36	5 21	6 39	5 18	6 42	5 15	6 45	5 12	6 48	5 9	6 51
37	5 26	6 34	5 23	6 37	5 20	6 40	5 17	6 43	5 13	6 47	5 10	6 50	5 7	6 53
38	5 25	6 35	5 22	6 38	5 18	6 42	5 15	6 45	5 12	6 48	5 8	6 52	5 5	6 55
39	5 24	6 36	5 20	6 40	5 17	6 43	5 13	6 47	5 10	6 50	5 6	6 54	5 3	6 57
40	5 22	6 38	5 19	6 41	5 15	6 45	5 12	6 48	5 8	6 52	5 4	6 56	5 1	6 59
41	5 21	6 39	5 17	6 43	5 14	6 46	5 10	6 50	5 6	6 54	5 2	6 58	4 58	7 2
42	5 20	6 40	5 16	6 44	5 12	6 48	5 8	6 52	5 4	6 56	5 0	7 0	4 56	7 4
43	5 18	6 42	5 14	6 46	5 10	6 50	5 6	6 54	5 2	6 58	4 58	7 2	4 54	7 6
44	5 17	6 43	5 13	6 47	5 8	6 52	5 4	6 56	5 0	7 0	4 56	7 4	4 51	7 9
45	5 15	6 45	5 11	6 49	5 7	6 53	5 2	6 58	4 58	7 2	4 53	7 7	4 49	7 11
46	5 14	6 46	5 9	6 51	5 5	6 55	5 0	7 0	4 56	7 4	4 51	7 9	4 46	7 14
47	5 12	6 48	5 7	6 53	5 3	6 57	4 58	7 2	4 53	7 7	4 48	7 12	4 43	7 17
48	5 10	6 50	5 5	6 55	5 1	6 59	4 56	7 4	4 51	7 9	4 46	7 14	4 41	7 19
49	5 8	6 52	5 3	6 57	4 58	7 2	4 53	7 7	4 48	7 12	4 43	7 17	4 38	7 22
50	5 6	6 54	5 1	6 59	4 56	7 4	4 51	7 9	4 46	7 14	4 40	7 20	4 35	7 25
51	5 4	6 56	4 59	7 1	4 54	7 6	4 48	7 12	4 43	7 17	4 37	7 23	4 31	7 29
52	5 2	6 58	4 57	7 3	4 51	7 9	4 46	7 14	4 40	7 20	4 34	7 26	4 28	7 32
53	5 0	7 0	4 54	7 6	4 49	7 11	4 43	7 17	4 37	7 23	4 31	7 29	4 24	7 36
54	4 58	7 2	4 52	7 8	4 46	7 14	4 40	7 20	4 33	7 27	4 27	7 33	4 20	7 40
55	4 56	7 4	4 49	7 11	4 43	7 17	4 37	7 23	4 30	7 30	4 23	7 37	4 16	7 44
56	4 53	7 7	4 47	7 13	4 40	7 20	4 33	7 27	4 26	7 34	4 19	7 41	4 12	7 48
57	4 50	7 10	4 44	7 16	4 37	7 23	4 30	7 30	4 23	7 37	4 15	7 45	4 8	7 52
58	4 47	7 13	4 40	7 20	4 33	7 27	4 26	7 34	4 18	7 42	4 11	7 49	4 3	7 57
59	4 44	7 16	4 37	7 23	4 30	7 30	4 22	7 38	4 14	7 46	4 6	7 54	3 58	8 2
60	4 41	7 19	4 34	7 26	4 26	7 34	4 18	7 42	4 9	7 51	4 1	7 59	3 52	8 8
61	4 38	7 22	4 30	7 30	4 22	7 38	4 13	7 47	4 4	7 56	3 55	8 5	3 46	8 14
62	4 34	7 26	4 26	7 34	4 17	7 43	4 8	7 52	3 59	8 1	3 49	8 11	3 40	8 20
63	4 30	7 30	4 21	7 39	4 12	7 48	4 3	7 57	3 53	8 7	3 43	8 17	3 33	8 27
64	4 26	7 34	4 17	7 43	4 7	7 53	3 57	8 3	3 47	8 13	3 36	8 24	3 25	8 35
65	4 21	7 39	4 12	7 48	4 1	7 59	3 51	8 9	3 40	8 20	3 28	8 32	3 16	8 44
66	4 18	7 42	4 6	7 54	3 55	8 5	3 44	8 16	3 32	8 28	3 20	8 40	3 7	8 53
66½	4 14	7 46	4 3	7 57	3 52	8 8	3 40	8 20	3 28	8 32	3 15	8 45	3 1	8 59
Lat.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris	Sett.	Ris

Latitude and Declination of *contrary* Names.

APPARENT TIME OF THE SUN'S RISING AND SETTING

Declination, of the *same* Name as the Latitude

Lat.	18° Ris.	18° Sett.	19° Ris.	19° Sett.	20° Ris.	20° Sett.	21° Ris.	21° Sett.	22° Ris.	22° Sett.	23° Ris.	23° Sett.	23½° Ris.	23½° Sett.
0°	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m	6h 0m
2	5 58	6 2	5 58	6 2	5 58	6 2	5 57	6 3	5 57	6 3	5 57	6 3	5 57	6 3
4	5 55	6 5	5 55	6 5	5 55	6 5	5 54	6 6	5 54	6 6	5 53	6 7	5 53	6 7
6	5 52	6 8	5 52	6 8	5 52	6 8	5 51	6 9	5 51	6 9	5 50	6 10	5 50	6 10
8	5 50	6 10	5 49	6 11	5 49	6 12	5 48	6 12	5 47	6 12	5 47	6 13	5 46	6 14
10	5 47	6 13	5 46	6 14	5 46	6 15	5 45	6 16	5 44	6 16	5 43	6 17	5 43	6 17
12	5 44	6 16	5 44	6 17	5 43	6 18	5 42	6 19	5 41	6 20	5 40	6 21	5 39	6 21
14	5 41	6 19	5 40	6 20	5 39	6 21	5 38	6 22	5 37	6 23	5 36	6 24	5 35	6 25
16	5 39	6 21	5 37	6 23	5 36	6 24	5 35	6 25	5 33	6 27	5 32	6 28	5 31	6 29
18	5 36	6 24	5 34	6 26	5 33	6 27	5 31	6 29	5 30	6 30	5 28	6 32	5 28	6 32
20	5 33	6 27	5 31	6 29	5 30	6 30	5 28	6 32	5 26	6 34	5 24	6 36	5 24	6 30
21	5 31	6 29	5 30	6 30	5 28	6 32	5 26	6 34	5 24	6 36	5 22	6 38	5 22	6 38
22	5 30	6 30	5 28	6 32	5 26	6 34	5 24	6 36	5 22	6 38	5 21	6 39	5 20	6 40
23	5 28	6 32	5 26	6 34	5 24	6 36	5 22	6 38	5 21	6 39	5 19	6 41	5 18	6 42
24	5 27	6 33	5 25	6 35	5 23	6 37	5 21	6 39	5 19	6 41	5 16	6 44	5 15	6 45
25	5 25	6 35	5 23	6 37	5 21	6 39	5 19	6 41	5 17	6 43	5 14	6 46	5 13	6 47
26	5 24	6 36	5 21	6 39	5 19	6 41	5 17	6 43	5 15	6 45	5 12	6 48	5 11	6 49
27	5 22	6 38	5 20	6 40	5 17	6 43	5 15	6 45	5 12	6 48	5 10	6 50	5 9	6 51
28	5 20	6 40	5 18	6 42	5 15	6 45	5 13	6 47	5 10	6 50	5 8	6 52	5 7	6 53
29	5 18	6 42	5 16	6 44	5 13	6 47	5 11	6 49	5 8	6 52	5 6	6 54	5 4	6 56
30	5 17	6 43	5 14	6 46	5 11	6 49	5 9	6 51	5 6	6 54	5 3	6 57	5 2	6 58
31	5 15	6 45	5 12	6 48	5 9	6 51	5 7	6 53	5 4	6 56	5 1	6 59	5 0	7 0
32	5 13	6 47	5 10	6 50	5 7	6 53	5 4	6 56	5 2	6 58	4 59	7 1	4 57	7 3
33	5 11	6 49	5 8	6 52	5 5	6 55	5 2	6 58	4 59	7 1	4 56	7 4	4 55	7 5
34	5 9	6 51	5 6	6 54	5 3	6 57	5 0	7 0	4 57	7 3	4 53	7 7	4 52	7 8
35	5 7	6 53	5 4	6 56	5 1	6 59	4 58	7 2	4 54	7 6	4 51	7 9	4 49	7 11
36	5 5	6 55	5 2	6 58	4 59	7 1	4 55	7 5	4 52	7 8	4 48	7 12	4 46	7 14
37	5 3	6 58	5 0	7 0	4 56	7 4	4 53	7 7	4 49	7 11	4 45	7 15	4 44	7 16
38	5 1	6 59	4 58	7 2	4 53	7 7	4 50	7 10	4 46	7 14	4 43	7 17	4 41	7 19
39	4 59	7 1	4 55	7 5	4 51	7 9	4 48	7 12	4 44	7 16	4 40	7 20	4 38	7 22
40	4 57	7 3	4 53	7 7	4 49	7 11	4 45	7 15	4 41	7 19	4 37	7 23	4 35	7 25
41	4 54	7 6	4 50	7 10	4 46	7 14	4 42	7 18	4 38	7 22	4 33	7 27	4 31	7 29
42	4 52	7 8	4 48	7 12	4 43	7 17	4 39	7 21	4 35	7 25	4 30	7 30	4 28	7 32
43	4 49	7 11	4 45	7 15	4 41	7 19	4 36	7 24	4 31	7 29	4 27	7 33	4 24	7 36
44	4 47	7 13	4 42	7 18	4 38	7 22	4 33	7 27	4 28	7 32	4 23	7 37	4 21	7 39
45	4 44	7 16	4 39	7 21	4 35	7 25	4 30	7 30	4 25	7 35	4 20	7 40	4 17	7 43
46	4 41	7 19	4 36	7 24	4 31	7 29	4 26	7 34	4 21	7 39	4 16	7 44	4 13	7 47
47	4 38	7 22	4 33	7 27	4 28	7 32	4 23	7 37	4 17	7 43	4 12	7 48	4 9	7 51
48	4 35	7 25	4 30	7 30	4 25	7 35	4 19	7 41	4 13	7 47	4 7	7 53	4 5	7 55
49	4 32	7 28	4 27	7 33	4 21	7 39	4 15	7 45	4 9	7 51	4 3	7 57	4 0	8 0
50	4 29	7 31	4 23	7 37	4 17	7 43	4 11	7 49	4 5	7 55	3 58	8 2	3 55	8 5
51	4 25	7 35	4 19	7 41	4 13	7 47	4 7	7 53	4 0	8 0	3 54	8 6	3 50	8 10
52	4 22	7 38	4 15	7 45	4 9	7 51	4 2	7 58	3 55	8 5	3 48	8 12	3 45	8 15
53	4 18	7 42	4 11	7 49	4 4	7 56	3 58	8 2	3 50	8 10	3 43	8 17	3 39	8 21
54	4 14	7 46	4 7	7 53	4 0	8 0	3 52	8 8	3 45	8 15	3 37	8 23	3 33	8 27
55	4 9	7 51	4 2	7 58	3 55	8 5	3 47	8 13	3 39	8 21	3 31	8 29	3 27	8 33
56	4 5	7 55	3 57	8 3	3 49	8 11	3 41	8 19	3 33	8 27	3 24	8 36	3 20	8 40
57	4 0	8 0	3 52	8 8	3 44	8 16	3 35	8 25	3 26	8 34	3 17	8 43	3 12	8 48
58	3 55	8 5	3 46	8 14	3 38	8 22	3 28	8 32	3 19	8 41	3 9	8 51	3 4	8 56
59	3 49	8 11	3 40	8 20	3 31	8 29	3 21	8 39	3 11	8 49	3 0	9 0	2 55	9 5
60	3 43	8 17	3 34	8 26	3 24	8 36	3 13	8 47	3 2	8 58	2 51	9 9	2 45	9 15
61	3 36	8 24	3 26	8 34	3 16	8 44	3 5	8 55	2 53	9 7	2 40	9 20	2 34	9 26
62	3 29	8 31	3 18	8 42	3 7	8 53	2 55	9 5	2 42	9 18	2 28	9 32	2 21	9 39
63	3 22	8 38	3 10	8 50	2 58	9 2	2 44	9 16	2 30	9 30	2 14	9 46	2 6	9 54
64	3 13	8 47	3 0	9 0	2 47	9 13	2 32	9 28	2 16	9 44	1 58	10 2	1 48	10 12
65	3 3	8 57	2 50	9 10	2 35	9 25	2 18	9 42	2 0	10 0	1 38	10 22	1 26	10 34
66	2 53	9 7	2 37	9 23	2 21	9 39	2 2	9 58	1 39	10 21	1 10	10 50	0 51	11 9
66½	2 46	9 14	2 30	9 30	2 12	9 48	1 51	10 9	1 26	10 34	0 48	11 12	0 0	12 0
Lat.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.

Latitude and Declination of *contrary* Names.

APPROXIMATE APPARENT TIMES OF THE MERIDIAN PASSAGES OF THE PRINCIPAL FIXED STARS

ON THE FIRST DAY OF EACH MONTH, 1902.

Name		Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
		h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
α Andromedæ	*Alpheratz*	5 19	3 6	1 17	23 23	21 32	19 29	17 25	15 20	13 24	11 36	9 40	7 37
γ Pegasi	*Algenib*	5 24	3 11	1 22	23 28	21 37	19 34	17 30	15 25	13 29	11 41	9 45	7 42
α Phœnicis....................		5 37	3 24	1 35	23 41	21 50	19 47	17 43	15 38	13 42	11 54	9 58	7 55
α Cassiopeæ	*Schedar*	5 51	3 38	1 49	23 55	22 4	20 1	17 57	15 52	13 56	12 8	10 12	8 9
β Ceti	*Deneb Kaitos*	5 55	3 42	1 53	23 59	22 8	20 5	18 1	15 56	14 0	12 12	10 16	8 13
α Ursæ Minoris	*Polaris*	6 40	4 27	2 37	0 43	22 52	20 49	18 46	16 41	14 46	12 58	11 2	8 59
α Eridani	*Achernar*	6 50	4 37	2 48	0 54	23 3	21 0	18 56	16 51	14 55	13 7	11 11	9 8
γ Andromedæ	*Almach*	7 14	5 1	3 12	1 18	23 27	21 24	19 20	17 15	15 19	13 31	11 35	9 32
α Arietis	*Hamel*	7 18	5 5	3 16	1 22	23 31	21 28	19 24	17 19	15 23	13 35	11 39	9 36
α Ceti	*Menkar*	8 13	6 0	4 11	2 17	0 26	22 23	20 19	18 14	16 18	14 30	12 34	10 31
α Persei	*Mirfak*	8 33	6 20	4 31	2 37	0 46	22 43	20 39	18 34	16 38	14 50	12 54	10 51
α Tauri	*Aldebaran*	9 46	7 33	5 44	3 50	1 59	23 56	21 52	19 47	17 51	16 3	14 7	12 4
α Aurigæ	*Capella*	10 25	8 12	6 23	4 29	2 38	0 35	22 31	20 26	18 31	16 43	14 47	12 43
β Orionis	*Rigel*	10 26	8 13	6 24	4 30	2 39	0 36	22 32	20 27	18 31	16 43	14 47	12 43
β Tauri	*Nath*	10 36	8 23	6 34	4 40	2 49	0 46	22 42	20 37	18 41	16 53	14 57	12 54
δ Orionis....................		10 43	8 30	6 41	4 47	2 56	0 53	22 49	20 44	18 48	17 0	15 4	13 1
ε Orionis	*Alnilam*	10 47	8 34	6 45	4 51	3 0	0 57	22 53	20 48	18 52	17 4	15 8	13 5
α Columbæ	*Phact*	10 52	8 39	6 50	4 56	3 5	1 2	22 58	20 53	18 57	17 9	15 13	13 10
α Orionis	*Betelguese*	11 6	8 53	7 4	5 10	3 19	1 16	23 12	21 7	19 11	17 23	15 27	13 23
β Aurigæ	*Menkalinan*	11 8	8 55	7 6	5 13	3 21	1 18	23 14	21 9	19 13	17 25	15 29	13 26
α Argûs	*Canopus*	11 38	9 25	7 36	5 42	3 51	1 48	23 44	21 39	19 43	17 55	15 59	13 56
γ Geminorum	*Alhena*	11 48	9 35	7 46	5 52	4 1	1 58	23 54	21 49	19 53	18 5	16 9	14 6
α Canis Majoris	*Sirius*	11 57	9 44	7 55	6 1	4 10	2 7	0 3	21 58	20 2	18 14	16 18	14 14
ε Canis Majoris	*Adara*	12 11	9 58	8 9	6 15	4 24	2 21	0 17	22 12	20 16	18 28	16 32	14 28
α^2 Geminorum	*Castor*	12 44	10 31	8 42	6 48	4 57	2 54	0 50	22 45	20 49	19 1	17 5	15 2
α Canis Minoris	*Procyon*	12 50	10 37	8 48	6 54	5 3	3 0	0 56	22 51	20 55	19 7	17 11	15 8
β Geminorum	*Pollux*	12 55	10 42	8 53	6 59	5 8	3 5	1 1	22 56	21 0	19 12	17 16	15 13
ζ Argûs....................		13 16	11 3	9 14	7 20	5 29	3 26	1 22	23 17	21 21	19 33	17 37	15 34
δ Argûs....................		13 58	11 45	9 56	8 2	6 11	4 8	2 4	23 59	22 3	20 15	18 19	16 16
α Hydræ	*Alphard*	14 39	12 26	10 37	8 43	6 52	4 49	2 45	0 40	22 44	20 56	19 0	16 56
α Leonis	*Regulus*	15 19	13 6	11 17	9 23	7 32	5 29	3 25	1 20	23 24	21 36	19 40	17 37
γ^1 Leonis	*Algeiba*	15 30	13 17	11 28	9 34	7 43	5 40	3 36	1 31	23 35	21 47	19 51	17 48
η Argûs....................		15 57	13 44	11 55	10 1	8 10	6 7	4 3	1 58	0 2	22 14	20 18	18 15
α Ursæ Majoris	*Dubhe*	16 13	14 0	12 11	10 17	8 26	6 23	4 19	2 14	0 18	22 30	20 34	18 31
δ Leonis	*Zosma*	16 25	14 12	12 23	10 29	8 38	6 35	4 31	2 26	0 30	22 42	20 46	18 42
β Leonis	*Denebola*	17 0	14 47	12 58	11 4	9 13	7 10	5 6	3 1	1 5	23 17	21 21	19 17
γ Ursæ Majoris	*Phecda*	17 4	14 51	13 2	11 8	9 17	7 14	5 10	3 5	1 9	23 21	21 25	19 21
α^1 Crucis....................		17 37	15 24	13 35	11 41	9 50	7 47	5 43	3 38	1 42	23 54	21 58	19 54
β Corvi....................		17 45	15 32	13 43	11 49	9 58	7 55	5 51	3 46	1 50	0 2	22 6	20 2
α Canum Venaticorum		18 7	15 54	14 5	12 11	10 20	8 17	6 13	4 8	2 12	0 24	22 28	20 24
α Virginis	*Spica*	18 36	16 23	14 34	12 40	10 49	8 46	6 42	4 37	2 41	0 53	22 57	20 53
η Ursæ Majoris	*Benetnasch*	19 0	16 47	14 58	13 4	11 13	9 10	7 6	5 1	3 5	1 17	23 21	21 17
β Centauri....................		19 13	17 0	15 11	13 17	11 20	9 23	7 19	5 14	3 18	1 30	23 34	21 30
α Draconis	*Thuban*	19 18	17 5	15 16	13 22	11 31	9 28	7 24	5 19	3 23	1 35	23 39	21 35
α Boötis	*Arcturus*	19 27	17 14	15 25	13 31	11 40	9 37	7 33	5 28	3 32	1 44	23 48	21 44
α^2 Centauri....................		19 49	17 36	15 47	13 53	12 2	9 59	7 55	5 50	3 54	2 6	0 10	22 6
α Libræ	*Zuben el Genubi*	20 1	17 48	15 59	14 5	12 14	10 11	8 7	6 2	4 6	2 18	0 22	22 18
β Ursæ Minoris	*Kochab*	20 7	17 54	16 5	14 11	12 20	10 17	8 13	6 8	4 12	2 24	0 28	22 24
β Libræ	*Zuben el Chamali*	20 28	18 15	16 26	14 32	12 41	10 38	8 34	6 29	4 33	2 45	0 49	22 45
α Coronæ Borealis	*Alphacca*	20 47	18 34	16 45	14 51	13 0	10 57	8 53	6 48	4 52	3 4	1 8	23 4
α Serpentis	*Unukalhai*	20 55	18 42	16 53	14 59	13 8	11 5	9 1	6 56	5 0	3 12	1 16	23 12
β^1 Scorpii....................		21 15	19 2	17 13	15 19	13 28	11 25	9 21	7 16	5 20	3 32	1 36	23 32
α Scorpii	*Antares*	21 39	19 26	17 37	15 43	13 52	11 49	9 45	7 40	5 44	3 56	2 0	23 56
α Trianguli Australis		21 54	19 41	17 52	15 58	14 7	12 4	10 0	7 55	5 59	4 11	2 15	0 11
β Draconis	*Alwaid*	22 44	20 31	18 42	16 48	14 57	12 55	10 50	8 45	6 49	5 1	3 5	1 2
α Ophiuchi	*Ras Alhague*	22 46	20 33	18 44	16 50	14 59	12 57	10 52	8 47	6 51	5 3	3 7	1 4
γ Draconis	*Rastaban*	23 10	20 58	19 8	17 15	15 23	13 21	11 16	9 11	7 15	5 27	3 31	1 28
α Lyræ	*Vega*	23 49	21 37	19 47	17 54	16 3	14 0	11 56	9 51	7 55	6 7	4 11	2 7
α Aquilæ	*Altair*	1 2	22 49	20 59	19 6	17 15	15 12	13 8	11 3	9 7	7 19	5 23	3 20
α Pavonis....................		1 34	23 21	21 31	19 38	17 47	15 44	13 40	11 35	9 39	7 51	5 55	3 51
α Cygni	*Deneb*	1 54	23 41	21 51	19 58	18 7	16 4	14 0	11 55	9 59	8 11	6 15	4 11
α Cephei	*Alderamin*	2 32	0 19	22 30	20 36	18 45	16 42	14 38	12 33	10 37	8 49	6 53	4 50
ε Pegasi....................		2 55	0 42	22 53	20 59	19 8	17 5	15 1	12 56	11 0	9 12	7 16	5 13
α Gruis....................		3 18	1 5	23 16	21 22	19 31	17 28	15 24	13 19	11 23	9 35	7 39	5 36
β Gruis....................		3 53	1 40	23 51	21 57	20 6	18 3	15 59	13 54	11 58	10 10	8 14	6 11
α Piscis Aust.	*Fomalhaut*	4 8	1 55	0 6	22 12	20 21	18 18	16 14	14 9	12 13	10 25	8 29	6 26
α Pegasi	*Markab*	4 16	2 3	0 14	22 20	20 29	18 26	16 22	14 17	12 21	10 33	8 37	6 34

CORRECTION OF THE TIMES IN TABLE 27 FOR THE DAY OF THE MONTH.

To be *Subtracted.*

Days.	Jan	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0^h 0^m	0^h 0^m	0^h 0^m	0^h 0^m	0^h 0^m	0^h 0^m	0^h 0^m	0^h 0^m	0^h 0^m	0^h 0^m	0^h 0^m	0^h 0^m
2	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4
3	0 9	0 8	0 7	0 7	0 8	0 8	0 8	0 8	0 7	0 7	0 8	0 9
4	0 13	0 12	0 11	0 11	0 11	0 12	0 12	0 12	0 11	0 11	0 12	0 13
5	0 18	0 16	0 15	0 15	0 15	0 16	0 16	0 15	0 14	0 15	0 16	0 17
6	0 22	0 20	0 19	0 18	0 19	0 21	0 21	0 19	0 18	0 18	0 20	0 22
7	0 26	0 24	0 22	0 22	0 23	0 25	0 25	0 23	0 22	0 22	0 24	0 26
8	0 30	0 28	0 26	0 26	0 27	0 29	0 29	0 27	0 25	0 25	0 28	0 30
9	0 35	0 32	0 30	0 29	0 30	0 33	0 33	0 31	0 29	0 29	0 32	0 35
10	0 39	0 36	0 33	0 33	0 35	0 37	0 37	0 35	0 32	0 33	0 36	0 39
11	0 43	0 40	0 37	0 36	0 39	0 41	0 41	0 38	0 36	0 37	0 40	0 44
12	0 48	0 44	0 41	0 40	0 42	0 45	0 45	0 42	0 40	0 40	0 44	0 48
13	0 52	0 48	0 44	0 44	0 46	0 49	0 49	0 46	0 43	0 44	0 48	0 52
14	0 56	0 52	0 48	0 48	0 50	0 54	0 53	0 50	0 47	0 48	0 52	0 57
15	1 1	0 56	0 52	0 51	0 54	0 58	0 57	0 53	0 50	0 51	0 56	1 1
16	1 5	1 0	0 55	0 55	0 58	1 2	1 1	0 57	0 54	0 55	1 0	1 6
17	1 9	1 3	0 59	0 59	1 2	1 6	1 5	1 1	0 58	0 59	1 4	1 10
18	1 13	1 7	1 2	1 2	1 6	1 10	1 9	1 5	1 1	1 3	1 9	1 15
19	1 18	1 11	1 6	1 6	1 10	1 14	1 13	1 8	1 5	1 6	1 13	1 19
20	1 22	1 15	1 10	1 10	1 14	1 19	1 17	1 12	1 8	1 10	1 17	1 24
21	1 26	1 19	1 14	1 13	1 18	1 23	1 21	1 16	1 12	1 14	1 21	1 28
22	1 31	1 23	1 17	1 17	1 22	1 27	1 25	1 19	1 16	1 18	1 25	1 32
23	1 35	1 26	1 21	1 21	1 26	1 31	1 29	1 23	1 19	1 21	1 30	1 37
24	1 39	1 30	1 24	1 25	1 30	1 35	1 33	1 27	1 23	1 25	1 34	1 41
25	1 43	1 34	1 28	1 28	1 34	1 39	1 37	1 31	1 26	1 29	1 38	1 46
26	1 47	1 38	1 32	1 32	1 38	1 44	1 41	1 34	1 30	1 33	1 42	1 50
27	1 51	1 42	1 35	1 36	1 42	1 48	1 45	1 38	1 34	1 37	1 47	1 55
28	1 56	1 45	1 39	1 40	1 46	1 52	1 49	1 42	1 37	1 41	1 51	1 59
29	2 0		1 43	1 44	1 50	1 56	1 53	1 45	1 41	1 44	1 55	2 3
30	2 4		1 46	1 47	1 55	2 0	1 57	1 49	1 44	1 48	1 59	2 8
31	2 8		1 50		1 59		2 1	1 52		1 52		2 12

TABLE 28

CORRECTION OF THE TIME OF THE MOON'S MER. PASSAGE

Long.	Daily Variation of the Moon's Meridian Passage														Long. in time.
	40^m	42^m	44^m	46^m	48^m	50^m	52^m	54^m	56^m	58^m	60^m	62^m	64^m	66^m	H. M.
5°	1^m	1^m	1^m	1^m	1^m	1^m	1^m	1^m	1^m	1^m	1^m	1^m	1^m	1^m	0 20
10	1	1	1	1	1	1	1	1	2	2	2	2	2	2	0 40
20	2	2	2	3	3	3	3	3	3	3	3	3	4	4	1 20
30	3	3	4	4	4	4	4	4	5	5	5	5	5	5	2 0
40	4	5	5	5	5	5	6	6	6	6	7	7	7	7	2 40
50	6	6	6	6	7	7	7	7	8	8	8	9	9	9	3 20
60	7	7	7	8	8	8	9	9	9	10	10	10	11	11	4 0
70	8	8	9	9	9	10	10	10	11	11	12	12	13	13	4 40
80	9	9	10	10	11	11	12	12	12	13	13	14	14	15	5 20
90	10	10	11	11	12	12	13	13	14	14	15	15	16	16	6 0
100	11	12	12	13	13	14	14	15	16	16	17	17	18	18	6 40
110	12	13	13	14	15	15	16	16	17	18	18	19	20	20	7 20
120	13	14	15	15	16	17	17	18	19	19	20	21	21	22	8 0
130	14	15	16	17	17	18	19	19	20	21	22	22	23	24	8 40
140	16	16	17	18	19	19	20	21	22	23	23	24	25	26	9 20
150	17	17	18	19	20	21	22	22	23	24	25	26	27	27	10 0
160	18	18	20	20	21	22	23	24	25	26	27	28	28	29	10 40
170	19	20	21	22	23	24	25	25	26	27	28	29	30	31	11 20
180	20	21	22	23	24	25	26	27	28	29	30	31	32	33	12 0

HOUR ANGLE AND ALTITUDE OF A BODY UPON THE PRIME VERTICAL

Lat.	Declination 1°		2°		3°		4°		5°		6°		7°		8°	
	H. A.	Alt.	H. A.	Alt.	H. A.	Alt.	H. A.	Alt.	H. A.	Alt.	H. A.	Alt.	H. A.	Alt.	H. A.	Alt.
°	h m	°	h m	°	h m	°	h m	°	h m	°	h m	°	h m	°	h m	°
2	4 0	30·0														
3	4 42	19·5	3 13	41·8												
4	5 2	14·5	4 0	30·0	2 46	48·6										
5	5 14	11·5	4 26	23·6	3 33	36·9	2 28	53·2								
6	5 22	9·6	4 42	19·5	4 0	30·0	3 13	41·8	2 15	56·4						
7	5 27	8·2	4 54	16·6	4 19	25·4	3 42	34·9	2 58	45·7	2 4	59·1				
8	5 31	7·2	5 2	14·5	4 32	22·1	4 1	30·1	3 26	38·6	2 46	48·7	1 56	61·1		
9	5 35	6·4	5 9	12·8	4 43	19·5	4 15	26·5	3 46	33·8	3 14	41·9	2 37	51·2	1 50	62·8
10	5 37	5·8	5 14	11·6	4 51	17·3	4 27	23·7	4 1	30·1	3 34	37·0	3 3	44·6	2 29	53·3
11	5 39	5·3	5 19	10·5	4 57	15·9	4 36	21·6	4 13	27·2	3 49	33·1	3 23	39·7	2 55	46·8
12	5 41	4·8	5 22	9·6	5 3	14·6	4 43	19·6	4 23	24·8	4 1	30·2	3 39	35·9	3 14	42·0
13	5 43	4·5	5 25	8·9	5 8	13·4	4 49	18·1	4 31	22·8	4 12	27·7	3 51	32·8	3 30	38·2
14	5 44	4·1	5 28	8·3	5 11	12·5	4 55	16·8	4 38	21·1	4 20	25·6	4 2	30·2	3 43	35·1
15	5 45	3·9	5 30	7·7	5 15	11·7	4 59	15·6	4 44	19·7	4 28	23·8	4 11	28·1	3 53	32·5
16	5 46	3·6	5 32	7·3	5 18	10·9	5 4	14·7	4 49	18·4	4 34	22·3	4 19	25·2	4 3	30·3
17	5 47	3·4	5 34	6·8	5 21	10·3	5 7	13·8	4 53	17·3	4 40	20·9	4 25	24·6	4 10	28·4
18	5 48	3·2	5 35	6·5	5 23	9·7	5 10	13·1	4 58	16·4	4 44	19·8	4 31	23·2	4 17	26·8
19	5 48	3·1	5 37	6·2	5 25	9·2	5 13	12·4	5 1	15·5	4 49	18·7	4 36	22·0	4 24	25·3
20	5 49	2·9	5 38	5·8	5 27	8·8	5 15	11·8	5 4	14·8	4 53	17·8	4 41	20·8	4 29	24·0
21	5 50	2·8	5 39	5·6	5 29	8·4	5 18	11·2	5 7	14·1	4 56	17·0	4 45	19·8	4 35	22·8
22	5 50	2·7	5 40	5·3	5 30	8·0	5 20	10·7	5 10	13·4	5 0	16·2	4 49	19·0	4 39	21·8
23	5 51	2·6	5 41	5·1	5 32	7·7	5 22	10·3	5 12	12·8	5 3	15·5	4 53	18·2	4 43	20·8
24	5 51	2·5	5 42	4·9	5 33	7·4	5 24	9·8	5 15	12·4	5 5	14·9	4 56	17·4	4 46	20·0
25	5 51	2·4	5 43	4·7	5 34	7·1	5 25	9·5	5 17	11·9	5 8	14·3	4 59	16·8	4 50	19·2
26	5 52	2·3	5 44	4·6	5 35	6·8	5 27	9·1	5 19	11·5	5 10	13·8	5 2	16·1	4 53	18·5
27	5 52	2·2	5 44	4·4	5 36	6·6	5 28	8·8	5 20	11·1	5 12	13·3	5 4	15·5	4 56	17·8
28	5 52	2·1	5 45	4·3	5 37	6·4	5 30	8·5	5 22	10·7	5 14	12·8	5 7	15·0	4 59	17·2
29	5 53	2·1	5 45	4·1	5 38	6·2	5 31	8·2	5 24	10·3	5 16	12·4	5 9	14·6	5 1	16·7
30	5 53	2·0	5 46	4·0	5 39	6·0	5 32	8·0	5 25	10·0	5 18	12·1	5 11	14·1	5 4	16·2
31	5 53	2·0	5 47	3·8	5 40	5·8	5 33	7·8	5 27	9·7	5 20	11·7	5 13	13·7	5 6	15·7
32	5 54	1·9	5 47	3·8	5 41	5·7	5 34	7·6	5 28	9·5	5 21	11·4	5 15	13·3	5 8	15·2
33	5 54	1·8	5 48	3·7	5 41	5·5	5 35	7·4	5 29	9·2	5 23	11·1	5 16	12·9	5 10	14·8
34	5 54	1·8	5 48	3·6	5 42	5·4	5 36	7·2	5 30	9·0	5 24	10·8	5 18	12·6	5 12	14·4
35	5 54	1·8	5 49	3·5	5 43	5·2	5 37	7·0	5 31	8·7	5 25	10·5	5 20	12·3	5 14	14·0
36	5 54	1·7	5 49	3·4	5 43	5·1	5 38	6·8	5 32	8·5	5 27	10·2	5 21	12·0	5 15	13·7
37	5 55	1·7	5 49	3·3	5 44	5·0	5 39	6·7	5 33	8·3	5 28	10·0	5 22	11·7	5 17	13·4
38	5 55	1·6	5 50	3·2	5 45	4·8	5 39	6·5	5 34	8·1	5 29	9·8	5 24	11·4	5 19	13·1
39	5 55	1·6	5 50	3·2	5 45	4·8	5 40	6·4	5 35	8·0	5 30	9·6	5 25	11·2	5 20	12·8
40	5 55	1·5	5 50	3·1	5 46	4·7	5 41	6·2	5 36	7·8	5 31	9·4	5 26	10·9	5 21	12·5
41	5 55	1·5	5 51	3·0	5 46	4·6	5 42	6·1	5 37	7·6	5 32	9·2	5 28	10·7	5 23	12·2
42	5 56	1·5	5 51	3·0	5 47	4·5	5 42	6·0	5 38	7·5	5 33	9·0	5 29	10·5	5 24	12·0
43	5 56	1·5	5 51	2·9	5 47	4·4	5 43	5·9	5 38	7·3	5 34	8·8	5 30	10·3	5 25	11·8
44	5 56	1·4	5 52	2·8	5 48	4·3	5 43	5·8	5 39	7·2	5 35	8·6	5 31	10·1	5 27	11·5
45	5 56	1·4	5 52	2·8	5 48	4·2	5 44	5·7	5 40	7·1	5 36	8·5	5 32	9·9	5 28	11·3
46	5 56	1·4	5 52	2·8	5 48	4·2	5 45	5·6	5 41	7·0	5 37	8·4	5 33	9·7	5 29	11·1
47	5 56	1·4	5 53	2·7	5 49	4·1	5 45	5·5	5 41	6·8	5 37	8·2	5 34	9·6	5 30	11·0
48	5 56	1·3	5 53	2·7	5 49	4·0	5 46	5·4	5 42	6·7	5 38	8·1	5 35	9·4	5 31	10·8
49	5 57	1·3	5 53	2·6	5 50	4·0	5 46	5·3	5 43	6·6	5 39	8·0	5 35	9·3	5 32	10·6
50	5 57	1·3	5 53	2·6	5 50	3·9	5 47	5·2	5 43	6·5	5 40	7·8	5 36	9·1	5 33	10·5
51	5 57	1·3	5 54	2·6	5 50	3·8	5 47	5·1	5 44	6·4	5 40	7·7	5 37	9·0	5 34	10·3
52	5 57	1·3	5 54	2·5	5 51	3·8	5 47	5·1	5 44	6·3	5 41	7·6	5 38	8·9	5 35	10·2
53	5 57	1·3	5 54	2·5	5 51	3·8	5 48	5·0	5 45	6·3	5 42	7·5	5 39	8·8	5 36	10·0
54	5 57	1·2	5 54	2·5	5 51	3·7	5 48	5·0	5 45	6·2	5 42	7·4	5 40	8·6	5 37	9·9
55	5 57	1·2	5 54	2·4	5 52	3·7	5 49	4·9	5 46	6·1	5 43	7·3	5 40	8·5	5 37	9·8
56	5 57	1·2	5 55	2·4	5 52	3·6	5 49	4·8	5 46	6·0	5 44	7·2	5 41	8·4	5 38	9·6
57	5 57	1·2	5 55	2·4	5 52	3·6	5 50	4·8	5 47	6·0	5 45	7·1	5 42	8·3	5 39	9·5
58	5 57	1·2	5 55	2·4	5 52	3·5	5 50	4·7	5 47	5·8	5 45	7·1	5 42	8·3	5 40	9·4
59	5 58	1·2	5 55	2·3	5 53	3·5	5 50	4·7	5 48	5·8	5 46	7·0	5 43	8·2	5 41	9·3
60	5 58	1·1	5 55	2·3	5 53	3·5	5 51	4·6	5 48	5·8	5 46	6·9	5 44	8·1	5 41	9·2
61	5 59	1·1	5 56	2·3	5 53	3·4	5 51	4·6	5 49	5·7	5 47	6·8	5 44	8·0	5 42	9·1

HOUR ANGLE AND ALTITUDE OF A BODY UPON THE PRIME VERTICAL

DECLINATION

Lat.	1° H. A.	1° Alt.	2° H. A.	2° Alt.	3° H. A.	3° Alt.	4° H. A.	4° Alt.	5° H. A.	5° Alt.	6° H. A.	6° Alt.	7° H. A.	7° Alt.	8° H. A.	8° Alt.
°	h m	°	h m	°	h m	°	h m	°	h m	°	h m	°	h m	°	h m	°
62	5 58	1·1	5 56	2·3	5 54	3·4	5 51	4·5	5 49	5·7	5 47	6·8	5 45	7·9	5 43	9·1
63	5 58	1·1	5 56	2·2	5 54	3·4	5 52	4·5	5 50	5·6	5 48	6·7	5 46	7·8	5 44	9·0
64	5 58	1·1	5 56	2·2	5 54	3·3	5 52	4·4	5 50	5·6	5 48	6·7	5 46	7·8	5 44	8·9
65	5 58	1·1	5 56	2·2	5 54	3·3	5 53	4·4	5 51	5·5	5 49	6·6	5 47	7·7	5 45	8·8
66	5 58	1·1	5 56	2·2	5 55	3·3	5 53	4·4	5 51	5·5	5 49	6·6	5 47	7·7	5 46	8·7
67	5 58	1·1	5 57	2·2	5 55	3·2	5 53	4·3	5 51	5·4	5 50	6·5	5 48	7·6	5 46	8·7
68	5 58	1·1	5 57	2·1	5 55	3·2	5 54	4·3	5 52	5·4	5 50	6·5	5 49	7·5	5 47	8·6
69	5 58	1·1	5 57	2·1	5 55	3·2	5 54	4·3	5 52	5·4	5 51	6·4	5 49	7·5	5 48	8·6
70	5 59	1·1	5 57	2·1	5 56	3·2	5 54	4·2	5 53	5·3	5 51	6·4	5 50	7·4	5 48	8·5

°	9° H. A.	9° Alt.	10° H. A.	10° Alt.	11° H. A.	11° Alt.	12° H. A.	12° Alt.	13° H. A.	13° Alt.	14° H. A.	14° Alt.	15° H. A.	15° Alt.	16° H. A.	16° Alt.
10	1 44	64·3														
11	2 22	55·1	1 40	65·5												
12	2 47	48·8	2 16	56·6	1 35	66·6										
13	3 7	44·1	2 41	50·5	2 11	58·0	1 32	67·5								
14	3 32	40·3	3 0	45·9	2 35	52·1	2 6	59·2	1 29	68·5						
15	3 35	37·2	3 16	42·1	2 54	47·5	2 30	53·4	2 2	60·3	1 26	69·2				
16	3 46	34·6	3 28	39·1	3 9	43·8	2 49	49·0	2 26	54·7	1 58	61·4	1 23	69·9		
17	3 55	32·3	3 39	36·4	3 22	40·7	3 4	45·3	2 24	50·3	2 21	55·8	1 55	62·3	1 21	70·5
18	4 3	30·4	3 49	34·2	3 33	38·1	3 17	42·3	2 59	46·7	2 40	51·5	2 18	56·8	1 52	63·1
19	4 10	28·7	3 57	32·2	3 43	35·8	3 28	39·7	3 12	43·7	2 54	48·0	2 36	52·6	2 14	57·8
20	4 17	27·2	4 4	30·5	3 51	33·9	3 37	37·4	3 23	41·1	3 7	45·0	2 50	49·2	2 32	53·7
21	4 23	25·8	4 11	29·0	3 58	32·2	3 46	35·5	3 32	38·8	3 18	42·5	3 3	46·2	2 47	50·3
22	4 28	24·7	4 16	27·3	4 5	30·6	3 53	33·7	3 41	36·9	3 28	40·2	3 14	43·7	2 59	47·4
23	4 32	23·6	4 22	26·4	4 11	29·2	4 0	32·1	3 48	35·1	3 36	38·2	3 23	40·3	3 10	44·9
24	4 37	22·6	4 27	25·3	4 16	28·0	4 6	30·7	3 55	33·6	3 44	36·5	3 32	39·5	3 20	42·7
25	4 41	21·7	4 31	24·3	4 21	26·8	4 12	29·5	4 1	32·1	3 51	34·9	3 40	37·8	3 28	40·7
26	4 44	20·9	4 35	23·3	4 26	25·8	4 17	28·3	4 7	30·8	3 57	33·5	3 47	36·2	3 36	39·0
27	4 48	20·1	4 39	22·5	4 30	24·8	4 21	27·2	4 12	29·7	4 3	32·2	3 54	34·8	3 43	37·4
28	4 51	19·5	4 43	21·7	4 34	24·0	4 26	26·3	4 17	28·6	4 8	31·0	3 59	33·4	3 49	35·9
29	4 54	18·3	4 46	21·0	4 38	23·2	4 30	25·4	4 22	27·6	4 13	29·9	4 4	32·2	3 55	34·6
30	4 56	18·2	4 49	20·3	4 41	22·4	4 34	24·6	4 26	26·7	4 18	28·9	4 9	31·2	4 1	33·4
31	4 59	17·7	4 52	19·7	4 44	21·7	4 37	23·8	4 30	25·9	4 22	28·0	4 14	30·2	4 6	32·4
32	5 1	17·2	4 54	19·1	4 47	21·1	4 40	23·1	4 33	25·1	4 26	27·2	4 18	29·2	4 11	31·3
33	5 4	16·7	4 57	18·6	4 50	20·5	4 44	22·4	4 37	24·4	4 30	26·4	4 23	28·4	4 15	30·4
34	5 6	16·2	4 59	18·1	4 53	19·9	4 47	21·8	4 40	23·7	4 33	25·5	4 26	27·6	4 19	29·5
35	5 8	15·8	5 2	17·6	4 56	19·4	4 49	21·2	4 43	23·1	4 37	24·9	4 30	26·8	4 23	28·7
36	5 10	15·4	5 4	17·2	4 58	18·9	4 52	20·7	4 46	22·5	4 40	24·3	4 33	26·1	4 27	28·0
37	5 11	15·1	5 6	16·8	5 0	18·5	4 54	20·2	4 49	21·9	4 43	23·7	4 37	25·5	4 31	27·2
38	5 13	14·7	5 8	16·4	5 3	18·6	4 57	19·7	4 51	21·4	4 46	23·1	4 40	24·5	4 34	26·6
39	5 15	14·4	5 10	16·0	5 4	18·5	4 59	19·3	4 54	20·9	4 48	22·6	4 43	24·3	4 38	26·0
40	5 16	14·1	5 11	15·7	5 6	17·3	5 1	18·8	4 56	20·5	4 51	22·1	4 46	23·7	4 40	25·4
41	5 18	13·8	5 13	15·3	5 8	16·9	5 3	18·5	4 58	20·0	4 53	21·6	4 48	23·2	4 43	24·8
42	5 19	13·5	5 15	15·2	5 10	16·6	5 5	18·1	5 1	19·6	4 56	21·2	4 51	22·9	4 46	24·3
43	5 21	13·3	5 16	14·7	5 12	16·2	5 7	17·7	5 3	19·3	4 58	20·8	4 53	22·3	4 48	23·8
44	5 22	13·0	5 18	14·5	5 14	15·9	5 9	17·4	5 5	18·9	5 0	10·4	4 56	21·8	4 51	23·4
45	5 24	12·8	5 19	14·2	5 15	15·7	5 11	17·1	5 7	18·5	5 2	20·0	4 58	21·5	4 53	22·9
46	5 25	12·6	5 21	14·0	5 17	15·4	5 13	16·8	5 8	18·2	5 4	19·6	5 0	21·1	4 56	22·5
47	5 26	12·3	5 22	13·7	5 18	15·1	5 14	16·5	5 10	17·9	5 6	19·3	5 2	20·7	4 58	22·1
48	5 27	12·1	5 23	13·5	5 20	14·8	5 16	16·2	5 12	17·6	5 8	19·0	5 4	20·4	5 0	21·8
49	5 28	12·0	5 25	13·3	5 21	14·6	5 17	16·0	5 14	17·3	5 10	18·7	5 6	20·1	5 2	21·4
50	5 29	11·8	5 26	13·2	5 22	14·4	5 19	15·7	5 15	17·1	5 12	18·4	5 8	19·7	5 4	21·1
51	5 31	11·6	5 27	12·9	5 24	14·2	5 20	15·5	5 17	16·8	5 13	18·1	5 10	19·4	5 6	20·8
52	5 32	11·4	5 28	12·7	5 25	14·0	5 22	15·3	5 18	16·6	5 15	17·8	5 12	19·2	5 8	20·5
53	5 33	11·3	5 29	12·6	5 26	13·8	5 23	15·2	5 20	16·4	5 17	17·6	5 14	18·9	5 10	20·2
54	5 34	11·1	5 31	12·4	5 28	13·6	5 24	14·8	5 21	16·1	5 18	17·4	5 16	18·7	5 12	19·9
55	5 35	11·0	5 32	12·2	5 29	13·5	5 26	14·7	5 23	15·9	5 20	17·2	5 17	18·4	5 14	19·7
56	5 35	10·8	5 33	12·1	5 30	13·3	5 27	14·5	5 24	15·7	5 21	17·0	5 18	18·2	5 16	19·4
57	5 36	10·7	5 34	11·9	5 31	13·2	5 28	14·3	5 26	15·6	5 23	16·8	5 20	18·0	5 17	19·2
58	5 37	10·6	5 35	11·8	5 33	13·0	5 29	14·2	5 27	15·4	5 24	16·6	5 22	17·8	5 19	19·0

HOUR ANGLE AND ALTITUDE OF A BODY UPON THE PRIME VERTICAL

Lat.	Declination 9° H. A.	Alt.	10° H. A.	Alt.	11° H. A.	Alt.	12° H. A.	Alt.	13° H. A.	Alt.	14° H. A.	Alt.	15° H. A.	Alt.	16° H. A.	Alt.
°	h m	°	h m	°	h m	°	h m	°	h m	°	h m	°	h m	°	h m	°
59	5 38	10·5	5 36	11·7	5 33	12·8	5 31	14·0	5 28	15·2	5 26	16·4	5 23	17·6	5 20	18·8
60	5 39	10·4	5 37	11·6	5 34	12·7	5 32	13·8	5 29	15·0	5 27	16·2	5 24	17·4	5 22	18·6
61	5 40	10·3	5 38	11·4	5 35	12·6	5 33	13·7	5 31	15·9	5 28	16·0	5 26	17·2	5 23	18·4
62	5 41	10·2	5 38	11·3	5 36	12·5	5 34	13·6	5 32	14·8	5 30	15·9	5 27	17·0	5 25	18·2
63	5 41	10·1	5 39	11·2	5 37	12·4	5 35	13·5	5 33	14·6	5 31	15·7	5 29	16·8	5 26	18·0
64	5 42	10·0	5 40	11·1	5 38	12·2	5 36	13·4	5 34	14·5	5 32	15·6	5 30	16·7	5 28	17·8
65	5 43	9·9	5 41	11·0	5 39	12·1	5 37	13·3	5 35	14·4	5 33	15·5	5 31	16·6	5 29	17·7
66	5 44	9·8	5 42	10·9	5 40	12·0	5 38	13·2	5 36	14·2	5 34	15·3	5 33	16·4	5 31	17·6
67	5 45	9·8	5 43	10·8	5 41	12·0	5 39	13·0	5 37	14·1	5 36	15·2	5 34	16·3	5 32	17·4
68	5 45	9·7	5 44	10·8	5 42	11·9	5 40	13·0	5 39	14·0	5 37	15·1	5 35	16·2	5 33	17·3
69	5 46	9·6	5 44	10·7	5 43	11·8	5 41	12·8	5 40	13·9	5 38	15·0	5 36	16·1	5 35	17·2
70	5 47	9·6	5 45	10·6	5 44	11·7	5 42	12·8	5 41	13·8	5 39	14·9	5 37	16·0	5 36	17·0

°	17° H. A.	Alt.	18° H. A.	Alt.	19° H. A.	Alt.	20° H. A.	Alt.	21° H. A.	Alt.	22° H. A.	Alt.	23° H. A.	Alt.	24° H. A.	Alt.
18	1 19	72·0														
19	1 50	63·9	1 17	71·6												
20	2 11	58·7	1 47	64·6	1 16	72·1										
21	2 29	54·8	2 9	59·6	1 45	65·3	1 14	72·6								
22	2 43	51·3	2 26	55·6	2 6	60·3	1 43	65·9	1 13	73·1						
23	2 56	48·4	2 40	52·3	2 23	56·4	2 4	61·1	1 41	66·5	1 11	73·5				
24	3 7	46·0	2 53	49·4	2 37	53·2	2 21	57·2	2 2	61·8	1 39	67·1	1 10	73·9		
25	3 16	43·8	3 3	47·0	2 50	50·4	2 35	54·0	2 18	58·0	2 0	62·4	1 38	67·6	1 9	74·3
26	3 25	41·8	3 13	44·8	3 0	48·0	2 47	51·3	2 32	54·8	2 16	58·7	1 58	63·0	1 36	68·1
27	3 33	40·1	3 22	42·9	3 10	45·8	2 58	48·8	2 44	52·1	2 30	55·6	2 14	59·4	1 56	63·6
28	3 40	38·5	3 29	41·2	3 19	43·9	3 7	46·8	2 55	49·8	2 42	52·9	2 28	56·3	2 13	60·0
29	3 47	37·1	3 36	39·6	3 26	42·2	3 16	44·8	3 5	47·7	2 53	50·6	2 40	53·7	2 26	57·0
30	3 52	35·8	3 43	38·2	3 34	40·6	3 24	43·2	3 13	45·8	3 2	48·5	2 51	51·4	2 38	54·4
31	3 58	34·6	3 49	36·8	3 40	39·2	3 31	41·6	3 21	44·1	3 11	46·7	3 0	49·3	2 48	52·1
32	4 3	33·5	3 55	35·7	3 46	37·9	3 37	40·2	3 28	42·6	3 19	45·0	3 9	47·5	2 58	50·1
33	4 8	32·5	4 0	34·6	3 52	36·7	3 44	38·8	3 36	41·1	3 26	43·4	3 17	45·8	3 7	48·1
34	4 12	31·5	4 5	33·5	3 57	35·6	3 49	37·7	3 41	39·8	3 33	42·1	3 24	44·3	3 15	46·7
35	4 16	30·6	4 9	32·6	4 2	34·3	3 55	36·6	3 47	38·7	3 39	40·6	3 31	42·9	3 23	45·2
36	4 20	29·8	4 14	31·7	4 7	33·6	4 0	35·6	3 52	37·7	3 45	39·6	3 37	41·7	3 29	43·8
37	4 24	29·1	4 18	30·9	4 11	32·7	4 4	34·6	3 57	36·6	3 50	38·5	3 43	40·5	3 35	42·5
38	4 28	28·3	4 22	30·1	4 15	31·9	4 9	33·7	4 2	35·6	3 55	37·5	3 49	39·4	3 41	41·4
39	4 31	27·7	4 25	29·4	4 19	31·1	4 13	32·9	4 7	34·7	4 0	36·5	3 54	38·4	3 47	40·3
40	4 35	27·0	4 29	28·7	4 23	30·4	4 17	32·1	4 11	33·8	4 5	35·6	3 58	37·4	3 52	39·2
41	4 38	26·5	4 32	28·1	4 27	29·7	4 21	31·4	4 15	33·2	4 10	34·8	4 3	36·5	3 57	38·3
42	4 41	25·9	4 35	26·9	4 30	29·1	4 25	30·7	4 19	32·4	4 13	34·0	4 7	35·7	4 1	37·4
43	4 43	25·4	4 38	26·6	4 33	28·5	4 28	30·1	4 23	31·7	4 17	33·3	4 12	34·9	4 6	36·6
44	4 46	24·8	4 41	26·2	4 36	27·9	4 31	29·5	4 26	31·1	4 21	32·6	4 16	34·2	4 10	35·8
45	4 49	24·4	4 44	25·9	4 39	27·4	4 35	28·9	4 30	30·4	4 25	32·0	4 20	33·5	4 14	35·1
46	4 51	24·0	4 47	25·4	4 42	26·9	4 38	28·4	4 33	29·8	4 28	31·4	4 23	32·9	4 18	34·4
47	4 54	23·6	4 49	25·0	4 45	26·4	4 41	27·9	4 36	29·3	4 31	30·8	4 27	32·3	4 22	33·8
48	4 56	23·2	4 58	24·6	4 48	25·9	4 43	27·4	4 39	28·8	4 35	30·3	4 30	31·7	4 25	33·2
49	4 58	22·8	4 54	24·2	4 50	25·5	4 46	26·9	4 42	28·3	4 38	29·7	4 33	31·2	4 29	32·6
50	5 1	22·4	4 57	23·8	4 53	25·1	4 49	26·5	4 45	27·9	4 41	29·3	4 37	30·7	4 32	32·1
51	5 3	22·1	4 59	23·4	4 55	24·8	4 51	26·1	4 48	27·5	4 44	28·8	4 40	30·1	4 35	31·6
52	5 5	21·8	5 1	23·1	4 58	24·4	4 54	25·7	4 50	27·0	4 46	28·4	4 43	29·7	4 39	31·1
53	5 7	21·5	5 3	22·8	5 0	24·0	4 56	25·4	4 53	26·6	4 49	28·0	4 45	29·3	4 42	30·7
54	5 9	21·2	5 5	22·4	5 2	23·7	4 59	25·0	4 55	26·3	4 52	27·6	4 48	28·9	4 44	30·2
55	5 11	20·9	5 7	22·2	5 4	23·4	5 1	24·7	4 58	25·9	4 54	27·2	4 51	28·5	4 47	29·8
56	5 12	20·6	5 9	21·9	5 6	23·1	5 3	24·4	5 0	25·6	4 57	26·8	4 53	28·1	4 51	29·4
57	5 14	20·4	5 11	21·6	5 8	22·8	5 5	24·1	5 2	25·3	4 59	26·5	4 56	27·8	4 53	29·0
58	5 16	20·2	5 13	21·4	5 10	22·6	5 7	23·8	5 4	25·0	5 1	26·2	4 58	27·4	4 55	28·7
59	5 18	19·9	5 15	21·1	5 12	22·3	5 9	23·5	5 7	24·7	5 4	25·9	5 1	27·1	4 58	28·3
60	5 19	19·7	5 17	20·9	5 14	22·1	5 11	23·3	5 9	24·4	5 6	25·6	5 3	26·8	5 0	28·0
61	5 21	19·5	5 18	20·7	5 16	21·8	5 13	23·0	5 11	24·2	5 8	25·4	5 6	26·5	5 3	27·7
62	5 23	19·3	5 20	20·5	5 18	21·6	5 15	22·8	5 13	23·9	5 10	25·1	5 8	26·3	5 5	27·4
63	5 24	19·1	5 22	20·3	5 20	21·4	5 17	22·6	5 15	23·7	5 12	24·8	5 10	26·0	5 8	27·2
64	5 26	19·0	5 24	20·1	5 21	21·2	5 19	22·4	5 17	23·5	5 15	24·6	5 12	25·8	5 10	26·9

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Lat.	Declination 17° H. A.	17° Alt.	18° H. A.	18° Alt.	19° H. A.	19° Alt.	20° H. A.	20° Alt.	21° H. A.	21° Alt.	22° H. A.	22° Alt.	23° H. A.	23° Alt.	24° H. A.	24° Alt.
°	h m	°	h m	°	h m	°	h m	°	h m	°	h m	°	h m	°	h m	°
65	5 27	18·8	5 25	19·9	5 23	21·0	5 21	22·2	5 19	23·3	5 17	24·4	5 14	25·5	5 12	26·7
66	5 25	18·[illegible]	5 27	19·8	5 24	20·8	5 23	22·0	5 21	23·1	5 19	24·2	5 16	25·3	5 14	26·4
67	5 30	18·5	5 28	19·6	5 26	20·7	5 24	21·8	5 22	22·9	5 20	24·0	5 18	25·1	5 16	26·2
68	5 32	18·4	5 30	19·5	5 28	20·5	5 26	21·6	5 24	22·7	5 22	23·8	5 20	24·9	5 19	26·0
69	5 33	18·2	5 31	19·3	5 30	20·4	5 28	21·5	5 26	22·6	5 24	23·6	5 22	24·7	5 21	25·8
70	5 34	18·1	5 33	19·2	5 31	20·3	5 30	21·3	5 28	22·4	5 26	23·5	5 24	24·6	5 23	25·6

°	25° H. A.	25° Alt.	26° H. A.	26° Alt.	27° H. A.	27° Alt.	28° H. A.	28° Alt.	29° H. A.	29° Alt.	30° H. A.	30° Alt.	31° H. A.	31° Alt.	32° H. A.	32° Alt.
26	1 8	74·6														
27	1 35	68·6	1 7	74·9												
28	1 55	64·2	1 34	69·0	1 6	75·3										
29	2 11	60·6	1 53	64·7	1 33	69·5	1 6	75·5								
30	2 25	57·7	2 9	61·2	1 52	65·2	1 32	69·8	1 5	75·8						
31	2 36	55·1	2 22	58·3	2 8	61·8	1 51	65·7	1 31	70·3	1 4	76·1				
32	2 47	52·9	2 35	55·8	2 21	58·9	2 7	62·4	1 50	66·2	1 30	70·6	1 4	76·4		
33	2 56	50·9	2 45	53·0	2 33	56·5	2 20	59·5	2 6	62·9	1 49	66·6	1 29	71·0	1 3	73·6
34	3 5	49·1	2 55	51·6	2 44	54·3	2 32	57·1	2 19	60·1	2 5	63·4	1 48	67·1	1 28	71·4
35	3 13	47·5	3 3	49·8	2 53	52·3	2 42	54·9	2 31	57·7	2 17	60·7	2 4	63·8	1 47	67·5
36	3 20	46·0	3 11	48·2	3 2	50·6	2 51	53·0	2 41	55·6	2 29	58·3	2 17	61·2	2 3	64·3
37	3 27	44·6	3 19	46·7	3 10	49·0	3 0	51·3	2 51	53·7	2 40	56·2	2 28	58·8	2 16	61·7
38	3 33	43·0	3 25	45·4	3 17	47·5	3 8	49·7	2 59	51·9	2 49	54·3	2 39	56·8	2 28	59·3
39	3 39	42·2	3 32	44·1	3 24	46·2	3 16	48·2	3 7	50·4	2 58	52·6	2 49	54·9	2 38	57·3
40	3 45	41·1	3 38	43·3	3 30	44·9	3 23	46·9	3 15	49·0	3 6	51·1	2 58	5[illegible]·2	2 47	55·5
41	3 50	40·1	3 43	41·9	3 36	43·8	3 29	45·7	3 22	47·6	3 14	49·6	3 5	51·7	2 56	53·8
42	3 55	39·2	3 49	40·9	3 42	42·7	3 35	44·6	3 28	46·4	3 20	48·3	3 13	50·3	3 4	52·4
43	4 0	38·3	3 54	40·0	3 48	41·7	3 41	43·5	3 34	45·3	3 27	47·1	3 20	49·0	3 12	51·0
44	4 4	37·5	3 59	39·1	3 53	40·8	3 46	42·5	3 40	44·3	3 33	46·0	3 26	47·8	3 19	49·7
45	4 9	36·7	4 3	38·3	3 57	39·9	3 52	41·6	3 45	43·3	3 39	45·0	3 32	46·7	3 25	48·5
46	4 13	36·0	4 8	37·5	4 2	39·1	3 56	40·7	3 51	42·4	3 44	44·0	3 38	45·7	3 32	47·4
47	4 17	35·3	4 12	36·8	4 7	38·4	4 1	39·9	3 55	41·5	3 49	43·1	3 44	44·8	3 37	46·4
48	4 21	34·7	4 16	36·1	4 11	37·7	4 6	39·2	4 0	40·7	3 55	42·3	3 49	43·8	3 43	45·5
49	4 24	34·0	4 20	35·5	4 15	37·0	4 10	38·4	4 5	40·0	3 59	41·5	3 54	43·0	3 48	44·6
50	4 28	33·5	4 23	34·9	4 19	36·3	4 14	37·8	4 9	39·3	4 4	40·7	3 59	42·2	3 54	43·7
51	4 31	32·9	4 27	34·3	4 23	35·7	4 18	37·2	4 13	38·6	4 8	40·0	4 4	41·5	3 58	43·0
52	4 35	32·4	4 30	33·8	4 26	35·2	4 22	36·6	4 17	38·0	4 13	39·4	4 8	40·8	4 3	42·3
53	4 38	31·9	4 34	33·3	4 30	34·6	4 26	36·0	4 21	37·4	4 17	38·8	4 12	40·1	4 8	41·6
54	4 41	31·5	4 37	32·8	4 34	34·1	4 30	35·5	4 25	36·8	4 21	38·2	4 16	39·5	4 12	40·9
55	4 44	31·1	4 40	32·3	4 36	33·6	4 33	35·0	4 29	36·3	4 25	37·6	4 20	38·9	4 16	40·3
56	4 47	30·6	4 43	31·9	4 40	33·2	4 36	34·5	4 32	35·8	4 28	37·1	4 24	38·4	4 20	39·7
57	4 49	30·3	4 46	31·5	4 43	32·8	4 39	34·0	4 36	35·3	4 32	36·6	4 28	37·8	4 24	39·2
58	4 52	29·9	4 49	31·1	4 46	32·4	4 42	33·6	4 39	34·8	4 35	36·1	4 32	37·4	4 28	38·7
59	4 55	29·5	4 52	30·7	4 49	32·0	4 45	33·2	4 42	34·4	4 39	35·7	4 35	36·9	4 32	38·2
60	4 58	29·2	4 55	30·4	4 52	31·6	4 48	32·8	4 45	34·0	4 42	35·3	4 39	36·5	4 35	37·7
61	5 0	28·9	4 57	30·1	4 54	31·3	4 51	32·5	4 48	33·7	4 45	34·8	4 42	36·1	4 39	37·3
62	5 3	28·6	5 0	29·7	4 57	30·9	4 54	32·1	4 51	33·3	4 48	34·5	4 45	35·7	4 42	36·8
63	5 5	28·3	5 2	29·5	5 0	30·5	4 57	31·8	4 54	33·0	4 52	34·1	4 48	35·3	4 46	36·5
64	5 7	28·0	5 5	29·2	5 2	30·3	5 0	31·5	4 57	32·6	4 55	33·8	4 50	35·0	4 49	36·1
65	5 10	27·8	5 7	28·9	5 5	30·1	5 3	31·2	5 0	32·3	4 58	33·5	4 53	34·6	4 52	35·8
66	5 12	27·6	5 10	28·7	5 8	29·8	5 5	30·9	5 3	32·0	5 0	33·2	4 56	34·3	4 55	35·4
67	5 14	27·5	5 12	28·4	5 10	29·5	5 8	30·7	5 5	31·8	5 3	32·9	4 59	34·0	4 58	35·1
68	5 17	27·3	5 15	28·2	5 12	29·3	5 10	30·4	5 8	31·5	5 7	32·6	5 1	33·7	5 1	34·8
69	5 19	26·9	5 17	28·0	5 15	29·1	5 13	30·2	5 11	31·3	5 9	32·4	5 5	33·5	5 4	34·6
70	5 21	26·7	5 19	27·8	5 17	28·8	5 15	30·0	5 13	31·1	5 11	32·1	5 8	33·2	5 7	34·3

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Lat.	Declination 33° H. A.	33° Alt.	34° H. A.	34° Alt.	35° H. A.	35° Alt.	36° H. A.	36° Alt.	37° H. A.	37° Alt.	38° H. A.	38° Alt.	39° H. A.	39° Alt.	40° H. A.	40° Alt.
°	h m	°	h m	°	h m	°	h m	°	h m	°	h m	°	h m	°	h m	°
34	1 3	76·9														
35	1 28	71·7	1 2	77·1												
36	1 47	67·9	1 27	72·0	1 2	77·4										
37	2 2	64·8	1 46	68·3	1 27	72·4	1 1	77·6								
38	2 15	62·2	2 1	65·3	1 45	68·7	1 26	72·7	1 1	77·8						
39	2 27	59·9	2 14	62·7	2 1	65·7	1 45	69·1	1 26	73·0	1 1	78·0				
40	2 37	57·9	2 26	60·4	2 14	63·2	2 0	66·1	1 44	69·4	1 26	73·3	1 1	78·2		
41	2 47	56·1	2 36	58·5	2 25	61·0	2 13	63·6	2 0	66·5	1 44	69·8	1 25	73·6	1 1	78·5
42	2 55	54·5	2 46	56·7	2 36	59·0	2 25	61·4	2 13	64·1	1 59	66·9	1 44	70·1	1 25	73·9
43	3 3	53·0	2 55	55·1	2 45	57·2	2 35	59·5	2 24	61·9	2 12	64·5	1 59	67·3	1 43	70·5
44	3 11	51·6	3 3	53·6	2 54	55·7	2 45	57·8	2 35	60·0	2 24	62·4	2 12	64·9	1 59	67·7
45	3 18	50·4	3 10	52·3	3 2	54·2	2 54	56·2	2 44	58·3	2 34	60·5	2 24	62·8	2 12	65·4
46	3 25	49·2	3 17	51·0	3 10	52·8	3 2	54·8	2 53	56·8	2 44	58·8	2 34	61·0	2 23	63·3
47	3 30	48·1	3 24	49·8	3 17	51·6	3 9	53·5	3 1	55·4	2 53	57·3	2 44	59·3	2 34	61·5
48	3 37	47·1	3 30	48·8	3 24	50·5	3 17	52·3	3 9	54·1	3 1	55·9	2 53	57·8	2 44	59·9
49	3 43	46·2	3 36	47·8	3 30	49·5	3 23	51·1	3 16	52·8	3 9	54·7	3 1	56·5	2 53	58·4
50	3 48	45·3	3 42	46·8	3 36	48·5	3 30	50·1	3 23	51·8	3 16	53·5	3 9	55·5	3 1	57·0
51	3 53	44·5	3 48	46·0	3 42	47·6	3 36	49·1	3 30	50·4	3 23	52·4	3 16	54·1	3 9	55·8
52	3 58	43·7	3 53	45·2	3 47	46·8	3 42	48·2	3 36	49·8	3 30	51·4	3 23	53·0	3 16	54·7
53	4 2	43·0	3 58	44·4	3 53	45·9	3 47	47·4	3 42	48·9	3 36	50·4	3 30	52·0	3 23	53·6
54	4 7	42·3	4 3	43·7	3 58	45·1	3 53	46·6	3 47	48·1	3 42	49·5	3 36	51·1	3 30	52·6
55	4 12	41·7	4 7	43·0	4 3	44·4	3 58	45·8	3 53	47·3	3 47	48·7	3 42	50·2	3 36	51·7
56	4 16	41·1	4 12	42·4	4 7	43·8	4 3	45·1	3 58	46·5	3 53	47·9	3 48	49·4	3 42	50·8
57	4 20	40·5	4 16	41·8	4 12	43·1	4 7	44·5	4 3	45·8	3 58	47·2	3 53	48·6	3 48	50·0
58	4 24	40·0	4 20	41·2	4 16	42·5	4 12	43·9	4 8	45·2	4 3	46·5	3 58	47·9	3 53	49·3
59	4 28	39·4	4 24	40·7	4 20	42·0	4 16	43·3	4 12	44·6	4 8	45·9	4 4	47·1	3 59	48·6
60	4 32	39·0	4 28	40·2	4 25	41·5	4 21	42·7	4 17	44·0	4 13	45·3	4 8	46·6	4 4	47·9
61	4 36	38·5	4 32	39·7	4 29	41·0	4 25	42·2	4 21	43·5	4 17	44·7	4 13	46·0	4 9	47·3
62	4 39	38·2	4 36	39·3	4 33	40·5	4 29	41·7	4 26	42·9	4 22	44·2	4 18	45·5	4 14	46·7
63	4 43	37·7	4 40	38·8	4 36	40·1	4 33	41·3	4 30	42·5	4 26	43·7	4 23	44·9	4 19	46·2
64	4 47	37·3	4 43	38·5	4 40	39·6	4 37	40·8	4 34	42·0	4 30	43·2	4 27	44·4	4 23	45·7
65	4 49	36·9	4 47	38·1	4 44	39·3	4 41	40·4	4 38	41·6	4 35	42·8	4 31	44·0	4 28	45·2
66	4 53	36·6	4 50	37·7	4 47	38·9	4 44	40·0	4 42	41·2	4 39	42·4	4 35	43·5	4 32	44·7
67	4 56	36·3	4 53	37·4	4 51	38·5	4 48	39·7	4 45	40·8	4 43	42·0	4 40	43·1	4 37	44·3
68	4 59	36·0	4 57	37·1	4 54	38·2	4 52	39·3	4 49	40·5	4 46	41·6	4 44	42·7	4 41	43·8
69	5 2	35·7	5 0	36·8	4 58	37·9	4 55	39·0	4 53	40·1	4 50	41·2	4 48	42·4	4 45	43·5
70	5 5	35·4	5 3	36·5	5 1	37·6	4 59	38·7	4 56	39·8	4 54	40·9	4 51	42·0	4 49	43·2
°	41°		42°		43°		44°		45°		46°		47°		48°	
42	1 0	78·6														
43	1 25	74·1	1 0	78·8												
44	1 43	70·8	1 25	74·4	1 0	79·0										
45	1 58	68·1	1 43	71·1	1 25	74·7	1 0	79·2								
46	2 12	65·8	1 58	68·5	1 43	71·5	1 25	74·9	1 0	79·4						
47	2 23	63·8	2 12	66·2	1 58	68·8	1 43	71·8	1 25	75·2	1 0	79·6				
48	2 34	62·0	2 23	64·2	2 12	66·6	1 58	69·2	1 43	72·2	1 25	75·5	1 0	79·8		
49	2 44	60·4	2 33	62·4	2 23	64·6	2 12	67·0	1 58	69·5	1 43	72·4	1 25	75·7	1 0	79·9
50	2 53	58·9	2 44	60·9	2 34	62·9	2 23	65·1	2 12	67·4	1 59	69·9	1 43	72·7	1 25	75·9
51	3 1	57·6	2 53	59·4	2 44	61·3	2 34	63·4	2 24	65·5	2 12	67·8	1 59	70·2	1 44	73·0
52	3 9	56·4	3 1	58·1	2 53	59·9	2 44	61·8	2 34	63·8	2 24	65·9	2 12	68·1	1 59	70·6
53	3 16	55·2	3 9	56·9	3 1	58·6	2 53	60·4	2 44	62·3	2 35	65·2	2 24	66·3	2 13	68·5
54	3 23	54·2	3 17	55·8	3 9	57·5	3 2	59·2	2 54	60·9	2 45	62·8	2 35	64·7	2 25	66·7
55	3 30	53·2	3 24	54·8	3 17	56·4	3 10	58·0	3 2	59·7	2 54	61·4	2 45	63·2	2 36	65·1
56	3 36	52·3	3 30	53·8	3 24	55·3	3 17	56·9	3 10	58·5	3 3	60·2	2 55	61·9	2 46	63·7
57	3 43	51·5	3 37	52·9	3 31	54·4	3 25	55·9	3 18	57·5	3 11	59·1	3 3	60·7	2 55	62·4
58	3 48	50·7	3 43	52·1	3 37	53·5	3 32	55·0	3 25	56·5	3 19	58·0	3 12	59·6	3 4	61·2
59	3 54	49·9	3 49	51·3	3 44	52·7	3 38	54·1	3 32	55·6	3 26	57·0	3 20	58·6	3 13	60·2
60	3 59	49·2	3 55	50·6	3 50	51·9	3 44	53·3	3 39	54·7	3 33	56·2	3 27	57·6	3 20	59·1
61	4 5	48·6	4 0	49·9	3 55	51·2	3 51	52·6	3 45	53·9	3 40	55·3	3 34	56·7	3 28	58·2
62	4 10	48·0	4 6	49·3	4 1	50·6	3 56	51·8	3 52	53·2	3 46	54·5	3 41	55·9	3 35	57·3
63	4 15	47·4	4 11	48·7	4 [illegible]	49·9	4 2	51·2	3 57	52·5	3 53	53·8	3 48	55·2	3 42	56·5

APPARENT DIP OF THE SEA HORIZON

Ht.	Dip.
	′ ″
0	0 0
1	1 0
2	1 24
3	1 42
4	1 58
5	2 12
6	2 25
7	2 36
8	2 47
9	2 57
10	3 7
12	3 25
14	3 41
16	3 56
18	4 11
20	4 24
22	4 37
24	4 49
26	5 1
28	5 13
30	5 24
35	5 49
40	6 13
45	6 36
50	6 58
55	7 18
60	7 37
65	7 56
70	8 14
75	8 31
80	8 48
85	9 4
90	9 20
100	9 51
110	10 19
120	10 47
130	11 14
140	11 39
150	12 3
160	12 27
170	12 50
180	13 12
190	13 34
200	13 55
210	14 16
220	14 36
240	15 15
260	15 52
280	16 27
300	17 0

MEAN ASTRONOMICAL REFRACTION.

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°)

App. Alt.	Refrac.	D. to 10′	App. Alt.	Refrac.	D. to 10′	App. Alt.	Refrac.	D. to 10′	App. Alt.	Refrac.	D. to 10′
0° 0′	34′ 17″	122″	6° 10′	8′ 18″	12″	12° 50	4′ 11″	3·2″	35° 0′	1′ 23·2	″·50
10	32 15	112	15	8 12	12	13 0	4 8	3·1	30	1 21·7	·50
20	30 23	102	20	8 6	11	10	4 5	3·1	36 0	1 20·2	·47
30	28 41	94	25	8 1	11	20	4 2	3·0	30	1 18·8	·47
40	27 7	86	30	7 56	11	30	3 59	3·0	37 0	1 17·4	·47
50	25 41	78	35	7 50	11	40	3 56	2·9	30	1 16·0	·47
1 0	24 22	73	40	7 45	10	50	3 53	2·9	38 0	1 14·6	·43
10	23 9	67	45	7 40	10	14 0	3 50	2·8	30	1 13·3	·43
20	22 2	62	50	7 35	10	10	3 47	2·7	39 0	1 12·0	·43
30	21 0	58	55	7 30	10	20	3 45	2·6	30	1 10·7	·42
40	20 2	53	7 0	7 25	9	30	3 42	2·5	40 0	1 9·5	·40
50	19 9	49	5	7 20	9	40	3 40	2·5	41 0	1 7·1	·38
2 0	18 20	46	10	7 16	9	50	3 37	2·4	42 0	1 4·8	·35
10	17 34	44	15	7 11	9	15 0	3 35	2·4	43 0	1 2·6	·34
15	17 12	42	20	7 7	9	10	3 32	2·3	44 0	1 0·4	·34
20	16 51	40	25	7 3	9	20	3 30	2·2	45 0	0 58·4	·33
25	16 31	39	30	6 59	9	30	3 28	2·2	46 0	0 56·3	·32
30	16 11	38	35	6 54	9	40	3 25	2·1	47 0	0 54·4	·31
35	15 52	37	40	6 50	8	50	3 23	2·1	48 0	0 52·6	·30
40	15 34	36	45	6 46	8	16 0	3 21	2·1	49 0	0 50·7	·29
45	15 16	35	50	6 42	8	10	3 19	2·1	50 0	0 49·0	·28
50	14 59	34	55	6 38	8	20	3 17	2·1	51 0	0 47·3	·27
55	14 42	33	8 0	6 35	8	30	3 15	2·0	52 0	0 45·6	·26
3 0	14 26	32	5	6 31	7	40	3 13	2·0	53 0	0 44·0	·26
5	14 10	31	10	6 27	7	50	3 11	2·0	54 0	0 42·4	·25
10	13 55	30	15	6 23	7	17 0	3 9	1·9	55 0	0 40·9	·25
15	13 41	29	20	6 20	7	30	3 3	1·9	56 0	0 39·4	·25
20	13 27	28	25	6 16	7	18 0	2 58	1·8	57 0	0 37·9	·24
25	13 13	27	30	6 13	7	30	2 53	1·7	58 0	0 36·5	·24
30	13 0	26	35	6 9	7	19 0	2 48	1·6	59 0	0 35·1	·23
35	12 47	25	40	6 6	6	30	2 44	1·5	60 0	0 33·7	·22
40	12 34	25	45	6 3	6	20 0	2 39	1·4	61 0	0 32·4	·22
45	12 22	24	50	6 0	6	30	2 35	1·3	62 0	0 31·0	·22
50	12 10	24	55	5 57	6	21 0	2 31	1·2	63 0	0 29·8	·21
55	11 58	23	9 0	5 54	6	30	2 27	1·2	64 0	0 28·5	·21
4 0	11 47	22	5	5 51	6	22 0	2 24	1·1	65 0	0 27·2	·20
5	11 36	21	10	5 48	6	30	2 20	1·1	66 0	0 26·0	·20
10	11 26	21	15	5 45	6	23 0	2 17	1·0	67 0	0 24·8	·20
15	11 15	20	20	5 42	6	30	2 13	1·0	68 0	0 23·6	·20
20	11 5	20	25	5 39	6	24 0	2 10	1·0	69 0	0 22·4	·20
25	10 55	19	30	5 36	5	30	2 7	0·9	70 0	0 21·3	·20
30	10 46	19	35	5 33	5	25 0	2 5	0·9	71 0	0 20·1	·20
35	10 37	18	40	5 31	5	30	2 2	0·9	72 0	0 19·0	·19
40	10 28	18	50	5 25	5	26 0	1 59	0·9	73 0	0 17·9	·19
45	10 19	18	10 0	5 20	5	30	1 56	0·9	74 0	0 16·7	·18
50	10 10	17	10	5 15	5	27 0	1 54	0·8	75 0	0 15·7	·18
55	10 2	16	20	5 10	5	30	1 51	0·8	76 0	0 14·6	·18
5 0	9 54	16	30	5 6	5	28 0	1 49	0·8	77 0	0 13·5	·17
5	9 46	16	40	5 1	5	30	1 47	0·7	78 0	0 12·4	·17
10	9 38	15	50	4 56	4	29 0	1 45	0·7	79 0	0 11·3	·17
15	9 30	15	11 0	4 52	4	30	1 43	0·7	80 0	0 10·3	·17
20	9 23	15	10	4 48	4	30 0	1 41	0·7	81 0	0 9·2	·17
25	9 16	14	20	4 44	4	30	1 39	0·6	82 0	0 8·2	·17
30	9 9	14	30	4 40	4	31 0	1 37	0·6	83 0	0 7·2	·17
35	9 2	14	40	4 36	4	30	1 35	0·6	84 0	0 6·1	·17
40	8 55	13	50	4 32	4	32 0	1 33	0·6	85 0	0 5·1	·17
45	8 48	13	12 0	4 28	4	30	1 31	0·6	86 0	0 4·1	·17
50	8 42	13	10	4 25	4	33 0	1 30	0·6	87 0	0 3·1	·17
55	8 36	12	20	4 21	4	30	1 28	0·5	88 0	0 2·0	·17
6 0	8 30	12	30	4 18	4	34 0	1 26	0·5	89 0	0 1·0	·17
5	8 24		40	4 14		30	1 25		90 0	0 0	

CORRECTION OF THE MEAN REFRACTION FOR THE HEIGHT OF THE THERMOMETER

Therm.	Altitudes																	
	4°	5°	5½°	6°	6½°	7°	7½°	8°	9°	10°	12°	15°	20°	30°	40°	50°	70°	90°
°	*add*	*add*	*add*	*add*	*add*	*add*	*add*	*add*	*add*	*add*	*add*	*add*	*add*	*add*	*add*	*add*	*add*	
0	69″	61″	57″	54″	51″	48″	46″	43″	39″	36″	30″	25″	18″	12″	8″·1	5″·7	2″·5	0
2	66	58	55	51	48	46	43	41	37	34	29	23	18	11	7·7	5·4	2·4	0
4	63	56	52	49	46	44	41	39	36	32	28	22	17	11	7·4	5·2	2·3	0
6	60	53	50	47	44	42	39	37	34	31	26	21	16	10	7·0	4·9	2·1	0
8	57	50	47	44	42	40	37	36	32	29	25	20	15	10	6·7	4·7	2·0	0
10	55	48	45	42	40	37	35	34	31	28	24	19	14	9	6·3	4·4	1·9	0
12	51	45	42	40	37	35	34	32	29	26	22	18	14	9	6·0	4·2	1·8	0
14	48	42	40	37	35	33	32	30	27	25	21	17	13	8	5·6	4·0	1·7	0
16	44	40	37	35	33	31	30	28	26	23	20	16	12	8	5·3	3·7	1·6	0
18	42	37	35	33	31	29	28	26	24	22	19	15	11	7	5·0	3·5	1·5	0
20	39	35	33	31	29	28	26	25	22	20	17	14	11	7	4·6	3·3	1·4	0
22	36	32	30	29	27	25	24	23	21	19	16	13	10	6	4·3	3·0	1·3	0
24	33	30	27	26	25	24	22	21	19	17	15	12	9	6	4·0	2·8	1·2	0
26	30	27	26	24	23	22	20	19	18	16	14	11	8	5	3·7	2·6	1·1	0
28	28	25	23	22	21	20	19	18	16	15	12	10	8	5	3·3	2·4	1·0	0
30	26	23	21	20	19	18	17	16	15	13	11	9	7	4	3·0	2·1	0·9	0
32	22	20	19	18	17	16	15	14	13	12	10	8	6	4	2·7	1·9	0·8	0
34	21	18	17	16	15	14	13	13	12	10	9	7	5	3	2·4	1·7	0·7	0
36	18	16	15	14	13	12	12	11	10	9	8	6	5	3	2·1	1·5	0·6	0
38	15	13	12	12	11	10	10	9	9	8	7	5	4	3	1·8	1·3	0·5	0
40	13	11	10	10	9	9	8	8	7	6	5	4	3	2	1·5	1·0	0·4	0
42	10	9	8	8	7	7	7	6	6	5	4	3	3	2	1·2	0·8	0·4	0
44	7	6	6	6	5	5	5	5	5	4	3	3	2	1	0·9	0·6	0·3	0
46	5	4	4	4	4	3	3	3	3	2	2	2	1	1	0·6	0·4	0·2	0
48	2	2	2	2	2	2	2	2	1	1	1	1	1	0	0·3	0·2	0·1	0
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	sub.	*sub.*	*sub*	*sub.*	*sub.*	*sub.*	*sub.*	*sub.*	*sub.*	*sub.*	*sub.*	*sub.*	*sub.*	*sub.*	*sub.*	*sub.*	*sub.*	
52	2	2	2	2	1	1	1	1	1	1	1	1	1	0	0·3	0·2	0·1	0
54	4	4	4	4	3	3	3	3	3	2	2	2	1	1	0·6	0·4	0·2	0
56	7	6	6	6	5	5	5	5	4	4	3	3	2	1	0·9	0·6	0·3	0
58	9	8	8	7	7	7	6	6	5	5	4	3	3	2	1·1	0·8	0·3	0
60	11	10	10	9	9	8	8	8	7	6	5	4	3	2	1·4	1·0	0·4	0
62	14	13	12	11	10	10	9	9	8	7	6	5	4	2	1·7	1·2	0·5	0
64	17	15	14	13	12	12	11	10	9	9	7	6	4	3	2·0	1·4	0·6	0
66	19	17	16	15	14	13	12	12	11	10	8	7	5	3	2·2	1·6	0·7	0
68	21	19	18	16	16	15	14	13	12	11	9	8	6	4	2·5	1·8	0·8	0
70	23	21	19	18	17	16	15	15	13	12	10	8	6	4	2·8	2·0	0·8	0
72	25	22	21	20	19	18	17	16	15	13	11	9	7	4	3·0	2·1	0·9	0
74	27	24	23	22	21	19	18	17	16	14	12	10	8	5	3·3	2·3	1·0	0
76	29	26	25	23	22	21	20	19	17	16	13	11	8	5	3·6	2·5	1·1	0
78	31	28	27	25	24	22	21	20	18	17	14	12	9	6	3·8	2·7	1·2	0
80	33	30	28	27	25	24	23	22	20	18	15	12	9	6	4·1	2·9	1·3	0
82	36	32	30	28	27	25	24	23	21	19	16	13	10	6	4·3	3·1	1·3	0
84	38	34	32	30	28	27	26	24	22	20	17	14	10	7	4·6	3·2	1·4	0
86	40	36	34	32	30	28	27	26	23	21	18	15	11	7	4·9	3·4	1·5	0
88	43	38	35	33	31	30	28	27	24	22	19	15	12	7	5·1	3·6	1·6	0
90	45	39	37	35	33	31	30	28	26	23	[illegible]	16	12	8	5·3	3·8	1·6	0
92	47	41	39	36	35	33	31	29	27	24	21	17	13	8	5·6	3·9	1·7	0
94	49	43	40	38	36	34	32	31	28	26	22	18	13	8	5·8	4·1	1·8	0
96	51	45	42	40	37	37	34	32	29	27	23	18	14	9	6·1	4·3	1·9	0
98	53	46	44	41	39	37	35	33	30	28	23	19	14	9	6·3	4·5	1·9	0
100	55	48	45	43	40	38	36	35	31	29	24	20	15	9	6·5	4·6	2·0	0

CORRECTION OF THE MEAN REFRACTION FOR THE HEIGHT OF THE BAROMETER

Bar.	Altitudes																		Bar.
	4°	5°	5½°	6°	6½°	7°	7½°	8°	9°	10°	12°	15°	20°	30°	40°	50°	70°	90°	
sub.																			*add*
27·5	60″	50″	46″	42″	40″	37″	35″	33″	29″	27″	22″	18″	13″	8″	5″8	4″0	1″8	0	
27·6	57	48	44	41	38	36	34	32	28	26	21	17	13	8	5·5	3·8	1·7	0	
27·7	54	46	42	39	37	34	32	30	27	25	20	17	12	8	5·3	3·7	1·6	0	
27·8	51	44	40	37	35	33	31	29	26	24	20	16	12	7	5·1	3·5	1·5	0	
27·9	48	42	38	36	33	31	29	28	25	22	19	15	11	7	4·8	3·3	1·5	0	
28·0	46	40	37	34	32	30	28	26	24	21	18	14	11	7	4·6	3·2	1·4	0	
28·1	44	38	35	32	30	28	27	25	22	20	18	14	10	6	4·4	3·0	1·3	0	
28·2	41	36	33	31	29	27	25	24	21	19	17	13	10	6	4·1	2·9	1·3	0	
28·3	39	34	31	29	27	25	24	22	20	18	16	12	9	6	3·9	2·7	1·2	0	
28·4	37	32	29	27	25	24	22	21	19	17	15	12	8	5	3·7	2·6	1·1	0	
28·5	35	30	27	25	24	22	21	20	18	16	14	11	8	5	3·4	2·4	1·0	0	31·5
28·6	32	28	26	24	22	21	20	18	17	15	13	10	7	5	3·2	2·2	1·0	0	31·4
28·7	30	26	24	22	21	19	18	17	15	14	12	9	7	4	3·0	1·9	0·9	0	31·3
28·8	27	24	22	20	19	18	17	16	14	13	11	9	6	4	2·8	1·8	0·8	0	31·2
28·9	25	22	20	19	17	16	15	15	13	12	10	8	6	4	2·5	1·7	0·8	0	31·1
29·0	23	20	18	17	16	15	14	13	12	11	9	7	5	3	2·3	1·6	0·7	0	31·0
29·1	20	18	16	15	14	13	13	12	11	10	8	6	5	3	2·1	1·4	0·6	0	30·9
29·2	18	16	15	14	13	12	11	11	9	9	7	6	4	3	1·8	1·3	0·6	0	30·8
29·3	16	14	13	12	11	10	10	9	8	7	6	5	4	2	1·6	1·1	0·5	0	30·7
29·4	14	12	11	10	10	9	8	8	7	6	5	4	3	2	1·4	1·0	0·4	0	30·6
29·5	12	10	9	8	8	7	7	7	6	5	4	4	3	2	1·1	0·8	0·3	0	30·5
29·6	9	8	7	7	6	6	6	5	5	4	4	3	2	1	0·9	0·6	0·3	0	30·4
29·7	6	6	5	5	5	4	4	4	4	3	3	2	2	1	0·7	0·5	0·2	0	30·3
29·8	4	4	4	3	3	3	3	3	2	2	2	1	1	1	0·5	0·3	0·1	0	30·2
29·9	2	2	2	2	2	1	1	1	1	1	1	1	1	0	0·2	0·2	0·1	0	30·1
30·0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0·0	0	0	0	30·0

TABLE 34

THE SUN'S PARALLAX IN ALTITUDE, AND SEMIDIAMETER

Month	Semid.	Altitude										Semid.	Month
		0°	10°	20°	30°	40°	50°	60°	70°	80°	90°		
Jan. 1	16′ 17″	8″7	8″6	8″2	7″6	6″7	5″6	4″4	3·0	1·5	0″	16′ 15″	Dec. 1
Feb. 1	16 15	8·7	8·6	8·2	7·6	6·6	5·6	4·3	3·0	1·5	0	16 9	Nov. 1
Mar. 1	16 9	8·6	8·5	8·1	7·5	6·6	5·5	4·3	3·0	1·5	0	16 1	Oct. 1
Apr. 1	16 1	8·5	8·4	8·0	7·4	6·5	5·5	4·3	2·9	1·5	0	15 53	Sept. 1
May 1	15 53	8·4	8·3	8·0	7·3	6·5	5·4	4·2	2·9	1·5	0	15 47	Aug. 1
June 1	15 47	8·4	8·3	8·0	7·3	6·4	5·4	4·2	2·9	1·5	0	15 45	July 1

TABLE 35

DIP OF THE SHORE HORIZON

Dist. in Miles	Ht. of the Eye in ft.							
	5	10	15	20	25	30	35	40
½	6′	12′	17′	23′	28′	34′	40′	45′
1	3	6	9	12	15	17	20	23
1½	3	4	6	8	10	12	14	16
2	2	4	5	7	8	9	11	12
2½	2	3	4	6	7	8	9	10
3		3	4	5	6	7	8	9
3½		3	4	5	6	6	7	8
4		3	4	5	5	6	7	7
5			4	4	5	6	6	7
6					5	5	6	6

TABLE 36

Corresponding Thermometers, Fahrenheit, Centigrade, Réaumur.

F.	C.	R.	F.	C.	R.
°	°	°	°	°	°
0	−17·8	−14·2	60	15·6	12·4
1	−17·2	−13·8	61	16·1	12·9
2	−16·7	−13·3	62	16·7	13·3
3	−16·1	−12·9	63	17·2	13·8
4	−15·6	−12·4	64	17·8	14·2
5	−15·0	−12·0	65	18·3	14·7
6	−14·4	−11·6	66	18·9	15·1
7	−13·9	−11·1	67	19·4	15·6
8	−13·3	−10·7	68	20·0	16·0
9	−12·8	−10·2	69	20·6	16·4
10	−12·2	− 9·8	70	21·1	16·9
11	−11·7	− 9·3	71	21·7	17·3
12	−11·1	− 8·9	72	22·2	17·8
13	−10·6	− 8·4	73	22·8	18·2
14	−10·0	− 8·0	74	23·3	18·7
15	− 9·4	− 7·5	75	23·9	19·1
16	− 8·9	− 7·1	76	24·4	19·6
17	− 8·3	− 6·7	77	25·0	20·0
18	− 7·8	− 6·2	78	25·6	20·5
19	− 7·2	− 5·8	79	26·1	20·9
20	− 6·7	− 5·3	80	26·7	21·3
21	− 6·1	− 4·9	81	27·2	21·8
22	− 5·6	− 4·4	82	27·8	22·2
23	− 5·0	− 4·0	83	28·3	22·7
24	− 4·4	− 3·6	84	28·9	23·1
25	− 3·9	− 3·1	85	29·4	23·6
26	− 3·3	− 2·7	86	30·0	24·0
27	− 2·8	− 2·2	87	30·6	24·4
28	− 2·2	− 1·8	88	31·1	24·9
29	− 1·7	− 1·3	89	31·7	25·3
30	− 1·1	− 0·9	90	32·2	25·8
31	− 0·6	− 0·4	91	32·8	26·2
32	0	0	92	33·3	26·7
33	0·6	0·4	93	33·9	27·1
34	1·1	0·9	94	34·4	27·6
35	1·7	1·3	95	35·0	28·0
36	2·2	1·8	96	35·6	28·4
37	2·8	2·2	97	36·1	28·9
38	3·3	2·7	98	36·7	29·3
39	3·9	3·1	99	37·2	29·8
40	4·4	3·6	100	37·8	30·2
41	5·0	4·0	101	38·3	30·7
42	5·6	4·4	102	38·9	31·1
43	6·1	4·9	103	39·4	31·6
44	6·7	5·3	104	40·0	32·0
45	7·2	5·8	105	40·6	32·4
46	7·8	6·2	106	41·1	32·9
47	8·3	6·7	107	41·7	33·3
48	8·9	7·1	108	42·2	33·8
49	9·4	7·5	109	42·8	34·2
50	10·0	8·0	110	43·3	34·7
51	10·6	8·4	111	43·9	35·1
52	11·1	8·9	112	44·4	35·5
53	11·7	9·3	113	45·0	36·0
54	12·2	9·8	114	45·6	36·4
55	12·8	10·2	115	46·1	36·9
56	13·3	10·7	116	46·7	37·3
57	13·9	11·1	117	47·2	37·8
58	14·4	11·6	118	47·8	38·2
59	15·0	12·0	119	48·3	38·7
60	15·6	12·4	120	48·9	39·1

TABLE 37

Corresponding French & English Measures

Fr. Kilomètre, Mètre, Décimètre, Centimètre, Millimètre.
Eng. Nautical Miles, Feet, Inches.

Fr.	English				
No.	Miles corr. to Kil.	Feet corr. to Mètr.	Feet corr. to Décim.	In. corr. to Cent.	In. corr. to Mill.
1	0·539	3·28	0·33	0·39	0·04
2	1·079	6·56	0·66	0·79	0·08
3	1·618	9·84	0·98	1·18	0·12
4	2·158	13·12	1·31	1·57	0·16
5	2·697	16·40	1·64	1·97	0·20
6	3·237	19·68	1·97	2·36	0·24
7	3·776	22·97	2·30	2·76	0·28
8	4·316	26·25	2·62	3·15	0·31
9	4·855	29·53	2·95	3·54	0·35
10	5·394	32·81	3·28	3·94	0·39
20	10·79	65·62	6·56	7·87	0·79
30	16·18	98·43	9·84	11·81	1·18
40	21·58	131·2	13·1	15·75	1·57
50	26·97	164·0	16·4	19·69	1·97
60	32·37	196·9	19·7	23·62	2·36
70	37·76	229·7	23·0	27·56	2·76
80	43·15	262·5	26·2	31·50	3·15
90	48·55	295·3	29·5	35·43	3·54
100	53·94	328·1	32·8	39·4	3·94
200	107·9	656·2			7·87
300	161·8	984·3			11·81
400	215·8	1312·4			15·75
500	269·7	1640·4			19·68
600	323·7	1968·5			23·62
700	377·6	2296·6			27·56
800	431·5	2624·7			31·50
900	485·5	2952·8			35·43
1000	539·4	3280·9			39·37

Barometer Scales

Fr. Mill.	Eng In.
640	25·2
643	25·3
645	25·4
648	25·5
650	25·6
653	25·7
655	25·8
658	25·9
660	26·0
663	26·1
665	26·2
668	26·3
670	26·4
673	26·5
676	26·6
678	26·7
681	26·8
683	26·9
686	27·0
688	27·1
691	27·2
693	27·3
696	27·4
698	27·5
701	27·6
704	27·7
706	27·8
709	27·9
711	28·0
714	28·1
716	28·2
719	28·3
721	28·4
724	28·5
726	28·6
729	28·7
732	28·8
734	28·9
737	29·0
739	29·1
742	29·2
744	29·3
747	29·4
749	29·5
752	29·6
754	29·7
757	29·8
759	29·9
762	30·0
765	30·1
767	30·2
770	30·3
772	30·4
775	30·5
777	30·6
780	30·7
782	30·8
785	30·9
787	31·0

CORRECTIONS OF ALTITUDE OF THE SUN AND STARS

(Involving Dip, Refraction, ☉'s Semid. and Parallax),

FOR APPROXIMATE USE AT SEA.

The SUN. *Add* the Corr. to the Alt. of the *Lower* limb, *except where marked* –.

Alt.	Height of the Eye in Feet.																			Alt.
	8	10	12	14	16	18	20	22	24	26	28	30	32	34	37	40	45	50	60	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
4½	2·6	2·3	2·0	1·7	1·4	1·2	1·0	0·7	0·5	0·3	0·1	–·1	–·3	–·5	–·7	–1·0	–1·3	–1·7	–2·4	4½
5	3·5	3·2	2·9	2·6	2·4	2·1	1·9	1·6	1·4	1·2	1·0	0·8	0·7	0·5	0·2	0·0	–0·4	–0·8	–1·5	5
5½	4·2	3·9	3·6	3·3	3·1	2·9	2·7	2·4	2·2	2·0	1·8	1·6	1·4	1·2	1·0	0·7	0·3	–0·1	–0·7	5½
6	4·9	4·6	4·3	4·0	3·7	3·5	3·3	3·1	2·9	2·6	2·4	2·3	2·1	1·9	1·7	1·4	1·0	0·6	0·0	6
6½	5·4	5·1	4·8	4·5	4·3	4·0	3·8	3·6	3·4	3·2	3·0	2·8	2·6	2·4	2·2	2·0	1·6	1·2	0·6	6½
7	6·0	5·6	5·3	5·0	4·8	4·6	4·3	4·1	3·9	3·7	3·5	3·3	3·1	2·9	2·7	2·5	2·1	1·7	1·0	7
8	6·7	6·4	6·1	5·8	5·6	5·3	5·1	4·9	4·7	4·5	4·3	4·1	3·9	3·7	3·5	3·3	2·9	2·6	1·9	8
9	7·4	7·1	6·8	6·5	6·3	6·0	5·8	5·6	5·4	5·2	5·0	4·8	4·6	4·4	4·2	4·0	3·6	3·3	2·6	9
10	8·0	7·7	7·4	7·1	6·8	6·6	6·4	6·1	5·9	5·7	5·5	5·4	5·2	5·0	4·8	4·5	4·2	3·9	3·2	10
11	8·5	8·1	7·8	7·6	7·3	7·1	6·8	6·6	6·4	6·2	6·0	5·8	5·7	5·5	5·3	5·0	4·7	4·3	3·7	11
12	8·9	8·6	8·2	8·0	7·7	7·5	7·2	7·0	6·8	6·6	6·4	6·2	6·1	5·9	5·7	5·5	5·1	4·7	4·1	12
14	9·5	9·2	8·9	8·6	8·3	8·1	7·9	7·6	7·4	7·2	7·1	6·9	6·7	6·5	6·3	6·1	5·7	5·4	4·7	14
16	10·0	9·7	9·4	9·1	8·8	8·6	8·4	8·1	8·0	7·8	7·6	7·4	7·2	7·0	6·8	6·6	6·3	5·9	5·2	16
18	10·4	10·1	9·8	9·5	9·2	9·0	8·8	8·5	8·3	8·1	7·9	7·7	7·6	7·4	7·2	6·9	6·6	6·3	5·6	18
20	10·7	10·4	10·1	9·8	9·5	9·3	9·1	8·9	8·7	8·5	8·3	8·1	7·9	7·7	7·5	7·2	6·9	6·6	5·9	20
22	11·0	10·6	10·3	10·1	9·8	9·6	9·3	9·1	8·9	8·7	8·5	8·3	8·2	8·0	7·7	7·5	7·2	6·8	6·2	22
25	11·3	10·9	10·6	10·4	10·1	9·9	9·6	9·4	9·2	9·0	8·8	8·7	8·5	8·3	8·1	7·9	7·5	7·1	6·5	25
30	11·7	11·3	11·0	10·8	10·5	10·3	10·0	9·8	9·6	9·4	9·2	9·1	8·9	8·7	8·4	8·2	7·8	7·5	6·8	30
35	12·0	11·6	11·3	11·1	10·8	10·6	10·3	10·1	9·9	9·7	9·5	9·4	9·2	9·0	8·7	8·5	8·1	7·8	7·1	35
40	12·2	11·8	11·5	11·3	11·0	10·8	10·6	10·3	10·1	9·9	9·7	9·6	9·4	9·2	9·0	8·8	8·4	8·0	7·3	40
45	12·4	12·0	11·7	11·5	11·2	11·0	10·8	10·5	10·3	10·1	9·9	9·7	9·5	9·4	9·1	8·9	8·5	8·2	7·5	45
50	12·5	12·2	11·9	11·6	11·3	11·1	10·9	10·7	10·5	10·3	10·1	9·9	9·7	9·5	9·3	9·1	8·7	8·3	7·7	50
60	12·7	12·4	12·1	11·8	11·6	11·3	11·1	10·9	10·7	10·5	10·3	10·1	9·9	9·8	9·5	9·3	8·9	8·5	7·9	60
70	12·9	12·6	12·3	12·0	11·8	11·5	11·3	11·1	10·9	10·7	10·5	10·3	10·1	9·9	9·7	9·5	9·1	8·7	8·1	70
80	13·1	12·7	12·4	12·2	11·9	11·7	11·4	11·2	11·0	10·8	10·6	10·4	10·3	10·1	9·8	9·6	9·2	8·9	8·3	80
90	13·2	12·9	12·6	12·3	12·0	11·8	11·6	11·4	11·2	11·0	10·8	10·6	10·4	10·2	10·0	9·8	9·4	9·0	8·4	90

Month	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Correction to sun's alt.	′ +0·3	′ +0·2	′ +0·1	′ –0·1	′ –0·2	′ –0·2	′ –0·3	′ –0·2	′ –0·1	′ +0·1	′ +0·2	′ +0·3

A STAR. *Subtract* the Corr.

	Height of the Eye in Feet.																	
	10	12	14	16	18	20	22	24	26	28	30	32	34	37	40	45	50	60	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
4	14·8	15·1	15·4	15·7	16·0	16·2	16·4	16·6	16·8	17·0	17·2	17·4	17·6	17·9	18·1	18·4	18·8	19·6	4
4½	13·8	14·1	14·4	14·7	15·0	15·2	15·4	15·6	15·8	16·0	16·2	16·4	16·6	16·9	17·1	17·4	17·7	18·5	4½
5	12·9	13·2	13·5	13·8	14·1	14·3	14·5	14·7	14·9	15·1	15·3	15·5	15·7	16·0	16·2	16·5	16·9	17·6	5
5½	12·2	12·5	12·8	13·0	13·3	13·5	13·7	13·9	14·1	14·3	14·5	14·7	14·9	15·2	15·4	15·7	16·1	16·8	5½
6	11·5	11·8	12·1	12·4	12·6	12·8	13·0	13·2	13·4	13·6	13·8	14·0	14·2	14·5	14·7	15·0	15·3	16·2	6
6½	11·0	11·3	11·6	11·9	12·1	12·3	12·5	12·7	12·9	13·1	13·3	13·5	13·7	13·9	14·2	14·4	14·8	15·6	6½
7	10·5	10·8	11·1	11·4	11·6	11·8	12·0	12·2	12·4	12·6	12·8	13·0	13·2	13·4	13·7	14·0	14·4	15·0	7
8	9·6	9·9	10·2	10·5	10·8	11·0	11·2	11·4	11·6	11·8	12·0	12·2	12·4	12·6	12·9	13·2	13·6	14·3	8
9	8·9	9·2	9·5	9·8	10·1	10·3	10·5	10·7	10·9	11·1	11·3	11·5	11·7	11·9	12·2	12·6	13·0	13·7	9
10	8·4	8·7	9·0	9·3	9·6	9·8	10·0	10·2	10·4	10·6	10·8	10·9	11·1	11·3	11·6	12·0	12·3	13·0	10
11	7·9	8·2	8·5	8·8	9·1	9·3	9·5	9·7	9·9	10·1	10·3	10·4	10·6	10·8	11·1	11·5	11·9	12·5	11
12	7·5	7·8	8·1	8·4	8·6	8·9	9·1	9·3	9·5	9·7	9·9	10·0	10·2	10·4	10·6	11·0	11·4	12·0	12
14	6·9	7·2	7·5	7·8	8·0	8·3	8·5	8·7	8·9	9·1	9·3	9·4	9·6	9·8	10·1	10·5	10·8	11·5	14
16	6·4	6·7	7·0	7·3	7·5	7·8	8·0	8·2	8·4	8·6	8·8	9·0	9·1	9·3	9·6	10·0	10·4	11·0	16
18	6·0	6·3	6·6	6·9	7·2	7·4	7·6	7·8	8·0	8·2	8·4	8·5	8·7	8·9	9·2	9·6	10·0	10·6	18
20	5·7	6·0	6·3	6·6	6·9	7·1	7·3	7·5	7·7	7·9	8·1	8·2	8·4	8·6	8·9	9·2	9·6	10·2	20
22	5·5	5·8	6·1	6·3	6·6	6·8	7·0	7·2	7·4	7·6	7·8	8·0	8·1	8·4	8·6	8·9	9·3	9·8	22
25	5·2	5·5	5·8	6·0	6·3	6·5	6·7	6·9	7·1	7·3	7·5	7·7	7·8	8·1	8·3	8·6	9·0	9·5	25
30	4·8	5·1	5·4	5·6	5·9	6·1	6·3	6·5	6·7	6·9	7·1	7·2	7·4	7·7	7·9	8·3	8·7	9·3	30
35	4·5	4·8	5·1	5·3	5·6	5·8	6·0	6·2	6·4	6·6	6·8	7·0	7·2	7·4	7·6	8·0	8·4	9·0	35
40	4·3	4·6	4·9	5·1	5·3	5·5	5·8	6·0	6·2	6·4	6·5	6·7	6·9	7·1	7·4	7·8	8·2	8·7	40
45	4·1	4·4	4·7	4·9	5·1	5·4	5·6	5·8	6·0	6·2	6·3	6·5	6·7	7·0	7·2	7·6	8·0	8·5	45
50	3·9	4·2	4·5	4·7	5·0	5·2	5·4	5·6	5·8	6·0	6·2	6·4	6·5	6·8	7·0	7·4	7·8	8·3	50
60	3·7	4·0	4·2	4·5	4·8	5·0	5·2	5·4	5·6	5·8	6·0	6·1	6·3	6·6	6·8	7·1	7·5	8·1	60
70	3·5	3·8	4·0	4·3	4·5	4·7	5·0	5·2	5·4	5·6	5·7	5·9	6·1	6·3	6·6	6·9	7·3	7·9	70
80	3·3	3·5	3·8	4·1	4·3	4·6	4·8	5·0	5·2	5·4	5·6	5·7	5·9	6·2	6·4	6·7	7·1	7·7	80

CORRECTION OF THE MOON'S APPARENT ALTITUDE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°)

☽ App. Alt.	Horizontal Parallax 53′	54′	55′	56′	57′	58′	59′	60′	61′	″ of Par.	Corr. for ″ of Par. add. 0″	2″	4″	6″	8″	Cor. for ′ of Alt.
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	″	″	″	″	″	″	
0 0	19 14	20 14	21 14	22 14	23 14	24 14	25 14	26 14	27 14	0	0	2	4	6	8	
10	21 6	22 6	23 6	24 6	25 6	26 6	27 6	28 6	29 6	10	10	12	14	16	18	
20	22 51	23 51	24 51	25 51	26 51	27 51	28 51	29 51	30 51	20	20	22	24	26	28	
30	24 28	25 28	26 28	27 28	28 28	29 28	30 28	31 28	32 28	30	30	32	34	36	38	
40	25 58	26 58	27 58	28 58	29 58	30 58	31 58	32 58	33 58	40	40	42	44	46	48	
50	27 21	28 21	29 21	30 21	31 21	32 21	33 21	34 21	35 21	50	50	52	54	56	58	
1 0	28 39	29 39	30 39	31 39	32 39	33 39	34 39	35 39	36 39	0	0	2	4	6	8	
10	29 49	30 49	31 49	32 49	33 49	34 49	35 49	36 49	37 49	10	10	12	14	16	18	
20	30 56	31 56	32 56	33 56	34 56	35 56	36 56	37 56	38 56	20	20	22	24	26	28	
30	31 57	32 57	33 57	34 57	35 57	36 57	37 57	38 57	39 57	30	30	32	34	36	38	
40	32 54	33 54	34 54	35 54	35 54	37 54	38 54	39 54	40 54	40	40	42	44	46	48	
50	33 46	34 46	35 46	36 46	37 46	38 46	39 46	40 46	41 46	50	50	52	54	56	58	
2 0	34 36	35 36	36 36	37 36	38 36	39 36	40 36	41 36	42 36	0	0	2	4	6	8	
10	35 22	36 22	37 22	38 22	39 22	40 22	41 22	42 22	43 22	10	10	12	14	16	18	
20	36 4	37 4	38 4	39 4	40 4	41 4	42 4	43 4	44 4	20	20	22	24	26	28	
30	36 44	37 44	38 44	39 44	40 44	41 44	42 44	43 44	44 44	30	30	32	34	36	38	
40	37 21	38 21	39 21	40 21	41 21	42 21	43 21	44 21	45 21	40	40	42	44	46	48	
50	37 55	38 55	39 55	40 55	41 55	42 55	43 55	44 55	45 55	50	50	52	54	56	58	
3 0	38 28	39 28	40 28	41 28	42 28	43 28	44 28	45 28	46 28	0	0	2	4	6	8	
10	38 59	39 58	40 58	41 58	42 58	43 58	44 58	45 58	46 58	10	10	12	14	16	18	
20	39 27	40 27	41 27	42 27	43 26	44 26	45 26	46 26	47 26	20	20	22	24	26	28	
30	39 53	40 53	41 53	42 53	43 53	44 53	45 53	46 53	47 53	30	30	32	34	36	38	
40	40 19	41 18	42 18	43 18	44 18	45 18	46 18	47 18	48 18	40	40	42	44	46	48	
50	40 42	41 42	42 42	43 42	44 42	45 42	46 42	47 41	48 41	50	50	52	54	56	58	
4 0	41 5	42 5	43 4	44 4	45 4	46 4	47 4	48 4	49 4	0	0	2	4	6	8	
10	41 26	42 26	43 25	44 25	45 25	46 25	47 25	48 25	49 25	10	10	12	14	16	18	
20	41 46	42 45	43 45	44 45	45 45	46 45	47 45	48 44	49 44	20	20	22	24	26	28	
30	42 4	43 4	44 4	45 4	46 4	47 3	48 3	49 3	50 3	30	30	32	34	36	38	
40	42 22	43 22	44 22	45 21	46 21	47 21	48 21	49 21	50 20	40	40	42	44	46	48	
50	42 39	43 38	44 38	45 38	46 38	47 38	48 37	49 37	50 37	50	50	52	54	56	58	
5 0	42 54	43 54	44 54	45 54	46 54	47 53	48 53	49 53	50 53	0	0	2	4	6	8	
10	43 9	44 9	45 9	46 9	47 9	48 8	49 8	50 8	51 8	10	10	12	14	16	18	
20	43 24	44 23	45 23	46 23	47 23	48 22	49 22	50 22	51 22	20	20	22	24	26	28	
30	43 37	44 37	45 37	46 36	47 36	48 36	49 36	50 35	51 35	30	30	32	34	36	38	
40	43 50	44 50	45 49	46 49	47 49	48 49	49 49	50 48	51 48	40	40	42	44	46	48	
50	44 2	45 2	46 1	47 1	48 1	49 0	50 0	51 0	52 0	50	50	52	54	56	58	
6 0	44 14	45 13	46 13	47 13	48 12	49 12	50 12	51 11	52 11	0	0	2	4	6	8	
10	44 24	45 24	46 24	47 23	48 23	49 23	50 22	51 22	52 22	10	10	12	14	16	18	
20	44 35	45 34	46 34	47 34	48 33	49 33	50 33	51 32	52 32	20	20	22	24	26	28	
30	44 45	45 44	46 44	47 44	48 43	49 43	50 43	51 42	52 42	30	30	32	34	36	38	
40	44 54	45 54	46 53	47 53	48 53	49 52	50 52	51 52	52 52	40	40	42	44	46	48	
50	45 4	46 3	47 3	48 2	49 2	50 1	51 1	52 1	53 0	50	50	52	54	56	58	
7 0	45 12	46 12	47 11	48 11	49 11	50 10	51 10	52 9	53 9	0	0	2	4	6	8	
10	45 21	46 20	47 20	48 19	49 19	50 18	51 18	52 17	53 17	10	10	12	14	16	18	
20	45 29	46 28	47 28	48 27	49 27	50 26	51 26	52 25	53 25	20	20	22	24	26	28	
30	45 36	46 35	47 35	48 34	49 34	50 33	51 33	52 32	53 32	30	30	32	34	36	38	
40	45 43	46 42	47 42	48 41	49 41	50 40	51 40	52 39	53 39	40	40	42	44	46	48	add
50	45 49	46 49	47 48	48 48	49 47	50 47	51 46	52 45	53 45	50	50	52	54	56	58	
8 0	45 55	46 55	47 54	48 54	49 53	50 53	51 52	52 52	53 51	0	0	2	4	6	8	1′ 1″
10	46 2	47 1	48 0	49 0	49 59	50 59	51 58	52 57	53 57	10	10	12	14	16	18	2 1
20	46 7	47 7	48 6	49 5	50 5	51 4	52 4	53 3	54 2	20	20	22	24	26	28	3 2
30	46 13	47 12	48 12	49 11	50 10	51 10	52 9	53 8	54 8	30	30	32	34	36	38	4 2
40	46 18	47 17	48 17	49 16	50 15	51 15	52 14	53 13	54 13	40	40	42	44	46	47	5 3
50	46 23	47 23	48 22	49 21	50 20	51 20	52 19	53 18	54 18	50	49	51	53	55	57	6 3
9 9	46 28	47 27	48 27	49 26	50 25	51 24	52 24	53 23	54 22	0	0	2	4	6	8	7 4
10	46 33	47 32	48 31	49 31	50 30	51 29	52 28	53 28	54 27	10	10	12	14	16	18	8 4
20	46 37	47 36	48 36	49 36	50 35	51 34	52 34	53 33	54 32	20	20	22	24	26	28	9 5
30	46 41	47 41	48 40	49 39	50 38	51 37	52 37	53 36	54 35	30	30	32	34	36	37	
40	46 45	47 45	48 44	49 43	50 42	51 41	52 40	53 39	54 39	40	39	41	43	45	47	
50	46 49	47 48	48 47	49 47	50 46	51 45	52 44	53 43	54 42	50	49	51	53	55	57	

CORRECTION OF THE MOON'S APPARENT ALTITUDE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°)

☽ App. Alt.	Horizontal Parallax									″ of Par.	Corr. for ″ of Par. add.					Cor. for ″ of Alt
	53′	54′	55′	56′	57′	58′	59′	60	61′		0″	2″	4″	6″	8″	
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	″	″	″	″	″	″	
10 0	46 53	47 52	48 51	49 50	50 49	51 48	52 47	53 46	54 46	0	0	2	4	6	8	add
10	46 56	47 55	48 54	49 53	50 53	51 52	52 51	53 50	54 49	10	10	12	14	16	18	′ ″
20	47 0	47 59	48 58	49 57	50 56	51 55	52 54	53 53	54 52	20	20	22	24	26	28	1 0
30	47 3	48 2	49 1	50 0	50 59	51 58	52 57	53 56	54 55	30	29	31	33	35	37	2 0
40	47 6	48 5	49 4	50 2	51 1	52 0	52 59	53 58	54 57	40	39	41	43	45	47	3 1
50	47 8	48 7	49 6	50 5	51 4	52 3	53 2	54 1	55 0	50	49	51	53	55	57	4 1
11 0	47 11	48 10	49 9	50 7	51 6	52 5	53 4	54 3	55 2	0	0	2	4	6	8	5 1
10	47 13	48 12	49 11	50 10	51 9	52 7	53 6	54 5	55 4	10	10	12	14	16	18	6 1
20	47 15	48 14	49 13	50 12	51 11	52 9	53 8	54 7	55 6	20	20	22	24	25	27	7 2
30	47 17	48 16	49 15	50 14	51 13	52 11	53 10	54 9	55 8	30	29	31	33	35	37	8 2
40	47 19	48 18	49 17	50 16	51 15	52 13	53 12	54 11	55 10	40	39	41	43	45	47	9 2
50	47 21	48 20	49 19	50 18	51 16	52 15	53 14	54 13	55 11	50	49	51	53	55	57	
12 0	47 23	48 22	49 21	50 19	51 18	52 17	53 15	54 14	55 13	0	0	2	4	6	8	
10	47 25	48 24	49 22	50 21	51 20	52 18	53 17	54 16	55 14	10	10	12	14	15	18	
20	47 27	48 25	49 24	50 23	51 21	52 20	53 19	54 17	55 16	20	20	21	23	25	27	
30	47 28	48 27	49 25	50 24	51 23	52 21	53 20	54 18	55 17	30	29	31	33	35	37	
40	47 30	48 28	49 27	50 25	51 24	52 22	53 21	54 20	55 18	40	39	41	43	45	47	
50	47 31	48 29	49 28	50 26	51 25	52 23	53 22	54 21	55 19	50	49	51	53	55	57	
13 0	47 32	48 30	49 29	50 27	51 26	52 24	53 23	54 21	55 20	0	0	2	4	6	8	
10	47 33	48 31	49 30	50 28	15 27	52 25	53 23	54 22	55 20	10	10	12	14	16	18	
20	47 34	48 32	49 31	50 29	51 27	52 26	53 24	54 22	55 21	20	19	21	23	25	27	
30	47 35	48 33	49 31	50 30	51 28	52 26	53 25	54 23	55 21	30	29	31	33	35	37	
40	47 35	48 34	49 32	50 30	51 29	52 27	53 25	54 23	55 22	40	39	41	43	45	47	1 0
50	47 36	48 34	49 33	50 31	51 29	52 27	53 26	54 24	55 22	50	49	51	53	54	56	2 0
14 0	47 37	48 35	49 33	50 31	51 30	52 28	53 26	54 24	55 22	0	0	2	4	6	8	3 0
10	47 37	48 35	49 33	50 32	51 30	52 28	53 26	54 24	55 22	10	10	12	14	15	17	4 0
20	47 37	48 36	49 34	50 32	51 30	52 28	53 26	54 24	55 22	20	19	21	23	25	27	5 0
30	47 38	48 36	49 34	50 32	51 30	52 28	53 26	54 24	55 22	30	29	31	33	35	37	6 0
40	47 38	48 36	49 34	50 32	51 30	52 28	53 26	54 24	55 22	40	39	41	43	45	46	7 0
50	47 38	48 36	49 34	50 32	51 30	52 28	53 26	54 24	55 22	50	48	50	52	54	56	8 0
15 0	47 38	48 36	49 34	50 32	51 30	52 28	53 26	54 24	55 22	0	0	2	4	6	8	9 0
10	47 38	48 36	49 34	50 32	51 30	52 28	53 26	54 24	55 22	10	10	12	14	15	17	
20	47 38	48 36	49 34	50 32	51 30	52 28	53 25	54 23	55 21	20	19	21	23	25	27	
30	47 38	48 36	49 34	50 31	51 29	52 27	53 25	54 23	55 21	30	29	31	33	35	37	
40	47 38	48 36	49 33	50 31	51 29	52 27	53 24	54 22	55 20	40	39	40	42	44	46	
50	47 37	48 35	49 33	50 31	51 28	52 26	53 24	54 22	55 19	50	48	50	52	54	56	
16 0	47 37	48 35	49 32	50 30	51 28	52 26	53 23	54 21	55 19	0	0	2	4	6	8	
10	47 37	48 34	49 32	50 30	51 27	52 25	53 22	54 20	55 18	10	10	12	13	15	17	
20	47 36	48 34	49 31	50 29	51 26	52 24	53 22	54 19	55 17	20	19	21	23	25	27	
30	47 35	48 33	49 31	50 28	51 26	52 23	53 21	54 18	55 16	30	29	31	33	35	36	
40	47 35	48 32	49 30	50 27	51 25	52 22	53 20	54 17	55 15	40	38	40	42	44	46	
50	47 34	48 32	49 29	50 26	51 24	52 21	53 19	54 16	55 14	50	48	50	52	54	56	
17 0	47 33	48 31	49 28	50 26	51 23	52 20	53 18	54 15	55 13	0	0	2	4	6	8	sub.
10	47 33	48 30	49 27	50 25	51 22	52 19	53 17	54 14	55 11	10	10	12	13	15	17	′ ″
20	47 32	48 29	49 26	50 24	51 21	52 18	53 15	54 13	55 10	20	19	21	23	25	27	1 0
30	47 31	48 28	49 25	50 22	51 20	52 17	53 14	54 11	55 9	30	29	30	32	34	36	2 0
40	47 30	48 27	49 24	50 21	51 18	52 16	53 13	54 10	55 7	40	38	40	42	44	46	3 0
50	47 29	48 26	49 23	50 20	51 17	52 14	53 11	54 9	55 6	50	48	50	52	53	55	4 0
18 0	47 28	48 25	49 22	50 19	51 16	52 13	53 10	54 7	55 4	0	0	2	4	6	8	5 0
10	47 26	48 23	49 20	50 17	51 15	52 12	53 9	54 6	55 3	10	9	11	13	15	17	6 0
20	47 25	48 22	49 19	50 16	51 14	52 10	53 7	54 4	55 1	20	19	21	23	25	27	7 0
30	47 24	48 21	49 18	50 15	51 12	52 9	53 5	54 2	54 59	30	28	30	32	34	36	8 0
40	47 23	48 20	49 16	50 13	51 10	52 7	53 4	54 1	54 58	40	38	40	42	44	46	9 1
50	47 21	48 18	49 15	50 12	51 8	52 5	53 2	53 59	54 56	50	47	49	51	53	55	
19 0	47 20	48 17	49 13	50 10	51 7	52 4	53 0	53 57	54 54	0	0	2	4	6	8	
10	47 18	48 15	49 12	50 8	51 5	52 2	52 59	53 55	54 52	10	9	11	13	15	17	
20	47 17	48 13	49 10	50 7	51 3	52 0	52 57	53 53	54 50	20	19	21	23	25	26	
30	47 15	48 12	49 8	50 5	51 2	51 58	52 55	53 51	54 48	30	28	30	32	34	36	
40	47 14	48 10	49 7	50 3	51 0	51 56	52 53	53 49	54 46	40	38	40	41	43	45	
50	47 12	48 8	49 5	50 1	50 58	51 54	52 51	53 47	54 44	50	47	49	51	53	55	

CORRECTION OF THE MOON'S APPARENT ALTITUDE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°)

☽ App. Alt.	Horizontal Parallax 53′	54′	55′	56′	57′	58′	59′	60′	61′	″ of Par.	Corr. for ″ of Par. *add.* 0″	2″	4″	6″	8″	Cor. for ′ of Alt.
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	″	″	″	″	″	″	
20 0	47 10	48 7	49 3	49 59	50 56	51 52	52 49	53 45	54 41	0	0	2	4	6	7	*sub.*
10	47 9	48 5	49 1	49 58	50 54	51 50	52 47	53 43	54 39	10	9	11	13	15	17	′ ″
20	47 7	48 3	48 59	49 56	50 52	51 48	52 44	53 41	54 37	20	19	21	22	24	26	1 0
30	47 5	48 1	48 57	49 54	50 50	51 46	52 42	53 38	54 35	30	28	30	32	34	36	2 0
40	47 3	47 59	48 55	49 51	50 48	51 44	52 40	53 36	54 32	40	37	39	41	43	45	3 1
50	47 1	47 57	48 53	49 49	50 45	51 41	52 38	53 34	54 30	50	47	49	51	52	54	4 1
21 0	46 59	47 55	48 51	49 47	50 43	51 39	52 35	53 31	54 27	0	0	2	4	6	7	5 1
10	46 57	47 53	48 49	49 45	50 41	51 37	52 33	53 29	54 25	10	9	11	13	15	17	6 1
20	46 55	47 51	48 47	49 43	50 38	51 34	52 30	53 26	54 22	20	19	20	22	24	26	7 2
30	46 53	47 49	48 44	49 40	50 36	51 32	52 28	53 24	54 19	30	28	30	32	34	35	8 2
40	46 51	47 46	48 42	49 38	50 34	51 29	52 25	53 21	54 17	40	37	39	41	43	45	9 2
50	46 48	47 44	48 40	49 35	50 31	51 27	52 23	53 18	54 14	50	47	48	50	52	54	
22 0	46 46	47 42	48 37	49 33	50 29	51 24	52 20	53 16	54 11	0	0	2	4	6	7	
10	46 44	47 39	48 35	49 30	50 26	51 22	52 17	53 13	54 8	10	9	11	13	15	17	
20	46 41	47 37	48 32	49 28	50 23	51 19	52 14	53 10	54 5	20	18	20	22	24	26	
30	46 39	47 34	48 30	49 25	50 21	51 16	52 12	53 7	54 3	30	28	30	31	33	35	
40	46 36	47 32	48 27	49 23	50 18	51 13	52 9	53 4	54 0	40	37	39	41	43	44	
50	46 34	47 29	48 25	49 20	50 15	51 11	52 6	53 1	53 57	50	46	48	50	52	54	
23 0	46 32	47 27	48 22	49 17	50 12	51 8	52 3	52 58	53 53	0	0	2	4	6	7	
10	46 29	47 24	48 19	49 15	50 10	51 5	52 0	52 55	53 50	10	9	11	13	15	17	
20	46 26	47 22	48 17	49 12	50 7	51 2	51 57	52 52	53 47	20	18	20	22	24	26	
30	46 24	47 19	48 14	49 9	50 4	50 59	51 54	52 49	53 44	30	28	29	31	33	35	
40	46 21	47 16	48 11	49 6	50 1	50 56	51 51	52 46	53 41	40	37	39	40	42	44	1′ 1
50	46 18	47 13	48 8	49 3	49 58	50 53	51 48	52 43	53 38	50	46	48	50	51	53	2 1
24 0	46 16	47 11	48 5	49 0	49 55	50 50	51 45	52 39	53 34	0	0	2	4	5	7	3 1
10	46 13	47 8	48 2	48 57	49 52	50 47	51 41	52 36	53 31	10	9	11	13	15	16	4 1
20	46 10	47 5	47 59	48 54	49 49	50 44	51 38	52 33	53 28	20	18	20	22	24	25	5 2
30	46 7	47 2	47 56	48 51	49 46	50 40	51 35	52 30	53 24	30	27	29	31	33	35	6 2
40	46 4	46 59	47 54	48 48	49 43	50 37	51 32	52 26	53 21	40	36	38	40	42	44	7 2
50	46 2	46 56	47 51	48 45	49 39	50 34	51 28	52 23	53 17	50	46	47	49	51	53	8 2
25 0	45 59	46 53	47 47	48 42	49 36	50 31	51 25	52 19	53 14	0	0	2	4	5	7	9 3
10	45 56	46 50	47 44	48 39	49 33	50 27	51 21	52 16	53 10	10	9	11	13	14	16	
20	45 53	46 47	47 41	48 35	49 29	50 24	51 18	52 12	53 6	20	18	20	22	23	25	
30	45 49	46 44	47 38	48 32	49 26	50 20	51 14	52 9	53 3	30	27	29	31	33	34	
40	45 46	46 40	47 35	48 29	49 23	50 17	51 11	52 5	52 59	40	36	38	40	42	43	
50	45 43	46 37	47 31	48 25	49 19	50 13	51 7	52 1	52 55	50	45	47	48	51	52	
26 0	45 40	46 34	47 28	48 22	49 16	50 10	51 4	51 58	52 52	0	0	2	4	5	7	
10	45 37	46 31	47 25	48 19	49 12	50 6	51 0	51 54	52 48	10	9	11	13	14	16	
20	45 34	46 27	47 21	48 15	49 9	50 3	50 56	51 50	52 44	20	18	20	22	23	25	
30	45 31	46 24	47 18	48 11	49 5	49 59	50 53	51 46	52 40	30	27	29	30	32	34	
40	45 27	46 21	47 14	48 8	49 2	49 55	50 49	51 42	52 36	40	36	38	39	41	43	
50	45 24	46 17	47 11	48 4	48 58	49 51	50 45	51 38	52 32	50	45	47	48	50	52	
27 0	45 20	46 14	47 7	48 1	48 54	49 48	50 41	51 35	52 28	0	0	2	4	5	7	
10	45 17	46 10	47 4	47 57	48 50	49 44	50 37	51 31	52 24	10	9	11	12	14	16	
20	45 13	46 7	47 0	47 53	48 47	49 40	50 33	51 27	52 20	20	18	20	21	23	25	1′ 0″
30	45 10	46 3	46 56	47 50	48 43	49 36	50 29	51 23	52 16	30	27	28	30	32	34	2 1
40	45 6	46 0	46 53	47 46	48 39	49 32	50 25	51 19	52 12	40	35	37	39	41	43	3 1
50	45 3	45 56	46 49	47 42	48 35	49 28	50 21	51 14	52 7	50	44	46	48	50	52	4 2
28 0	44 59	45 52	46 45	47 38	48 31	49 24	50 17	51 10	52 3	0	0	2	4	5	7	5 2
10	44 56	45 49	46 42	47 34	48 27	49 20	50 13	51 6	51 59	10	9	11	12	14	16	6 2
20	44 52	45 45	46 38	47 31	48 23	49 16	50 9	51 2	51 55	20	18	19	21	23	25	7 3
30	44 48	45 41	46 34	47 27	48 19	49 12	50 5	50 58	51 50	30	26	28	30	32	33	8 3
40	44 45	45 37	46 30	47 23	48 15	49 8	50 1	50 53	51 46	40	35	37	39	40	42	9 4
50	44 41	45 34	46 26	47 19	48 11	49 4	49 56	50 49	51 42	50	44	46	47	49	51	
29 0	44 37	45 30	46 22	47 15	48 7	49 0	49 52	50 45	51 37	0	0	2	3	5	7	
10	44 34	45 26	46 18	47 11	48 3	48 56	49 48	50 40	51 33	10	9	10	12	14	16	
20	44 30	45 22	46 14	47 7	47 59	48 51	49 44	50 36	51 28	20	17	19	21	23	24	
30	44 26	45 18	46 10	47 2	47 55	48 47	49 39	50 31	51 24	30	26	28	30	32	33	
40	44 22	45 14	46 6	46 58	47 51	48 43	49 35	50 27	51 19	40	35	37	38	40	42	
50	44 18	45 10	46 2	46 54	47 46	48 38	49 30	50 22	51 15	50	44	45	47	49	50	

CORRECTION OF THE MOON'S APPARENT ALTITUDE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°)

☽ App. Alt.	Horizontal Parallax 53′	54′	55′	56′	57′	58′	59′	60′	61′	″ of Par.	Corr. for ″ of Par. add. 0″	2″	4″	6″	8″	Cor. for ′ of Alt.
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	″	″	″	″	″	″	
30 0	44 14	45 6	45 58	46 50	47 42	48 34	49 26	50 18	51 10	0	0	2	3	5	7	
10	44 10	45 2	45 54	46 46	47 38	48 30	49 21	50 13	51 5	10	9	10	12	14	16	sub.
20	44 6	44 58	45 50	46 42	47 33	48 25	49 17	50 9	51 1	20	17	19	21	22	24	
30	44 2	44 54	45 46	46 37	47 29	48 21	49 12	50 4	50 56	30	26	28	29	31	33	1′ 0′
40	43 58	44 50	45 41	46 33	47 25	48 16	49 8	49 59	50 51	40	34	36	38	40	41	2 1
50	43 54	44 45	45 37	46 29	47 20	48 12	49 3	49 55	50 46	50	43	45	47	48	50	3 1
31 0	43 50	44 41	45 33	46 24	47 16	48 7	48 58	49 50	50 41	0	0	2	3	5	7	4 2
10	43 46	44 37	45 28	46 20	47 11	48 2	48 54	49 45	50 37	10	9	10	12	14	16	5 2
20	43 41	44 33	45 24	46 15	47 7	47 58	48 49	49 40	50 32	20	17	19	20	22	24	6 3
30	43 37	44 28	45 20	46 11	47 2	47 53	48 44	49 35	50 27	30	26	27	29	31	32	7 3
40	43 33	44 24	45 15	46 6	46 57	47 48	48 39	49 31	50 22	40	34	36	38	39	41	8 4
50	43 29	44 20	45 11	46 2	46 53	47 44	48 35	49 26	50 17	50	43	44	46	48	49	9 4
32 0	43 24	44 15	45 6	45 57	46 48	47 39	48 30	49 21	50 12	0	0	2	3	5	7	
10	43 20	44 11	45 2	45 53	46 43	47 34	48 25	49 16	50 7	10	8	10	12	13	15	
20	43 16	44 6	44 57	45 48	46 39	47 29	48 20	49 11	50 1	20	17	19	20	22	24	
30	43 11	44 2	44 53	45 43	46 34	47 24	48 15	49 6	49 56	30	25	27	29	30	32	
40	43 7	43 57	44 48	45 39	46 29	47 20	48 10	49 1	49 51	40	34	35	37	39	41	
50	43 3	43 53	44 43	45 34	46 24	47 15	48 5	48 56	49 46	50	42	44	46	47	49	
33 0	42 58	43 48	44 39	45 29	46 19	47 10	48 0	48 50	49 41	0	0	2	3	5	7	
10	42 54	43 44	44 34	45 24	46 15	47 5	47 55	48 45	49 36	10	8	10	12	13	15	
20	42 49	43 39	44 29	45 20	46 10	47 0	47 50	48 40	49 30	20	17	18	20	22	23	
30	42 45	43 35	44 24	45 15	46 5	46 55	47 45	48 35	49 25	30	25	27	28	30	32	
40	42 40	43 30	44 19	45 10	46 0	46 50	47 40	48 30	49 20	40	33	35	37	38	40	
50	42 35	43 25	44 14	45 5	45 55	46 45	47 35	48 24	49 14	50	42	44	45	47	48	
34 0	42 31	43 21	44 10	45 0	45 50	46 40	47 29	48 19	49 9	0	0	2	3	5	7	
10	42 26	43 16	44 6	44 55	45 45	46 34	47 24	48 14	49 3	10	8	10	12	13	15	
20	42 21	43 11	44 1	44 50	45 40	46 29	47 19	48 8	48 58	20	16	18	20	21	23	
30	42 17	43 6	43 56	44 45	45 35	46 24	47 14	48 3	48 53	30	25	27	28	30	31	
40	42 12	43 1	43 51	44 40	45 30	46 19	47 8	47 58	48 47	40	33	35	36	38	40	
50	42 7	42 57	43 46	44 35	45 24	46 14	47 3	47 52	48 41	50	41	43	44	46	48	
35 0	42 3	42 52	43 41	44 30	45 19	46 8	46 57	47 47	48 36	0	0	2	3	5	7	
10	41 58	42 47	43 36	44 25	45 14	46 3	46 52	47 41	48 30	10	8	10	11	13	15	
20	41 53	42 42	43 31	44 20	45 9	45 58	46 47	46 36	48 25	20	16	18	20	21	23	
30	41 48	42 37	43 26	44 15	45 3	45 52	46 41	47 30	48 19	30	24	26	28	29	31	
40	41 43	42 32	43 21	44 9	44 58	45 47	46 36	47 24	48 13	40	33	34	36	38	39	
50	41 38	42 27	43 16	44 4	44 53	45 41	46 30	47 19	48 7	50	41	42	44	46	47	1′ 1″
36 0	41 33	42 22	43 10	43 59	44 48	45 36	46 25	47 13	48 2	0	0	2	3	5	6	2 1
10	41 28	42 17	43 5	43 54	44 42	45 31	46 19	47 7	47 56	10	8	10	11	13	14	3 2
20	41 23	42 12	43 0	43 48	44 37	45 25	46 13	47 2	47 50	20	16	18	19	21	23	4 2
30	41 18	42 7	42 55	43 43	44 31	45 20	46 8	46 56	47 44	30	24	26	27	29	31	5 3
40	41 13	42 1	42 50	43 38	44 26	45 14	46 2	46 50	47 38	40	32	34	35	37	39	6 3
50	41 8	41 56	42 44	43 32	44 20	45 8	45 56	46 44	47 33	50	40	42	44	45	47	7 4
37 0	41 3	41 51	42 39	43 27	44 15	45 3	45 51	46 39	47 27	0	0	2	3	5	6	8 4
10	40 58	41 46	42 34	43 22	44 9	44 57	45 45	46 33	47 21	10	8	10	11	13	14	9 5
20	40 53	41 41	42 28	43 16	44 4	44 52	45 39	46 27	47 15	20	16	17	19	21	22	
30	40 48	41 35	42 23	43 11	43 58	44 46	45 33	46 21	47 9	30	24	26	28	29	31	
40	40 43	41 30	42 18	43 5	43 53	44 40	45 28	46 15	47 3	40	32	34	35	37	38	
50	40 37	41 25	42 12	43 0	43 47	44 34	45 22	46 9	46 57	50	40	41	43	44	46	
38 0	40 32	41 19	42 7	42 54	43 41	44 29	45 16	46 3	46 51	0	0	2	3	5	6	
10	40 27	41 14	42 1	42 48	43 36	44 23	45 10	45 57	46 44	10	8	9	11	12	14	1′ 1″
20	40 22	41 9	41 56	42 43	43 30	44 17	45 4	45 51	46 38	20	16	17	19	20	22	2 1
30	40 16	41 3	41 50	42 37	43 24	44 11	44 58	45 45	46 32	30	23	25	27	28	30	3 2
40	40 11	40 58	41 45	42 32	43 18	44 5	44 52	45 39	46 26	40	31	33	35	36	38	4 2
50	40 6	40 52	41 39	42 26	43 13	43 59	44 46	45 33	46 20	50	39	41	42	44	45	5 3
39 0	40 0	40 47	41 33	42 20	43 7	43 53	44 40	45 27	46 13	0	0	2	3	5	6	6 3
10	39 55	40 41	41 28	42 14	43 1	43 47	44 34	45 21	46 7	10	8	9	11	12	14	7 4
20	39 49	40 36	41 22	42 9	42 55	43 41	44 28	45 14	46 [illegible]	20	15	17	19	20	22	8 5
30	39 44	40 30	41 17	42 3	42 49	43 35	44 22	45 8	45 54	30	23	25	27	28	30	9 5
40	39 38	40 25	41 11	41 57	42 43	43 29	44 16	45 2	45 48	40	31	32	34	36	37	
50	39 33	40 19	41 5	41 51	42 37	43 23	44 9	44 56	45 42	50	39	40	42	43	45	

CORRECTION OF THE MOON'S APPARENT ALTITUDE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°)

☽ App. Alt.	Horizontal Parallax 53′	54′	55′	56′	57′	58′	59′	60′	61′	″ of Par.	Corr. for ″ of Par. *add.* 0″	2″	4″	6″	8″	Cor. for of Alt.
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	″	″	″	″	″	″	
40 0	39 27	40 13	40 59	41 45	42 31	43 17	44 3	44 49	45 35	0	0	1	3	5	6	
10	39 22	40 8	40 54	41 39	42 25	43 11	43 57	44 43	45 29	10	8	9	11	12	14	
20	39 16	40 2	40 48	41 33	42 19	43 5	43 51	44 36	45 22	20	15	17	18	20	21	
30	39 11	39 56	40 42	41 28	42 13	42 59	43 44	44 30	45 16	30	23	24	26	27	29	
40	39 5	39 51	40 36	41 22	42 7	42 53	43 38	44 24	45 9	40	30	32	33	35	36	
50	38 59	39 45	40 30	41 16	42 1	42 46	43 32	44 17	45 3	50	38	40	41	43	44	
41 0	38 54	39 39	40 24	41 10	41 55	42 40	43 25	44 11	44 56	0	0	1	3	4	6	
10	38 48	39 33	40 18	41 4	41 49	42 34	43 19	44 4	44 49	10	7	9	10	12	14	
20	38 42	39 27	40 12	40 58	41 43	42 28	43 13	43 58	44 43	20	15	16	18	19	21	
30	38 37	39 22	40 6	40 51	41 36	42 21	43 6	43 51	44 36	30	22	24	25	27	28	
40	38 31	39 16	40 0	40 45	41 30	42 15	43 0	43 45	44 30	40	30	31	33	34	36	
50	38 25	39 10	39 54	40 39	41 24	42 9	42 53	43 38	44 23	50	37	39	40	42	43	
42 0	38 19	39 4	39 48	40 33	41 18	42 2	42 47	43 31	44 16	0	0	1	3	4	6	
10	38 13	38 58	39 42	40 27	41 11	41 56	42 40	43 25	44 9	10	7	9	10	12	13	
20	38 8	38 52	39 36	40 21	41 5	41 49	42 34	43 18	44 3	20	15	16	18	19	21	
30	38 2	38 46	39 30	40 14	40 59	41 43	42 27	43 11	43 56	30	22	24	25	27	28	
40	37 56	38 40	39 24	40 8	40 52	41 36	42 21	43 5	43 49	40	29	31	32	34	36	s.b
50	37 50	38 34	39 18	40 2	40 46	41 30	42 14	42 58	43 42	50	37	38	40	41	43	
43 0	37 44	38 28	39 12	39 56	40 40	41 23	42 7	42 51	43 35	0	0	1	3	4	6	1′ 1
10	37 38	38 22	39 6	39 49	40 33	41 17	42 1	42 44	43 28	10	7	9	10	12	13	2 1
20	37 32	38 16	38 59	39 43	40 27	41 10	41 54	42 38	43 21	20	15	16	17	19	21	3 2
30	37 26	38 10	38 53	39 37	40 20	41 4	41 47	42 31	43 14	30	22	23	25	26	28	4 3
40	37 20	38 3	38 47	39 30	40 14	40 57	41 40	42 24	43 7	40	29	30	32	33	35	5 3
50	37 14	37 57	38 41	39 24	40 7	40 50	41 34	42 17	43 0	50	36	38	39	41	42	6 4
44 0	37 8	37 51	38 34	39 17	40 1	40 44	41 27	42 10	42 53	0	0	1	3	4	6	7 5
10	37 2	37 45	38 28	39 11	39 54	40 37	41 20	42 3	42 46	10	7	9	10	11	13	8 6
20	36 56	37 39	38 21	39 4	39 47	40 30	41 13	41 56	42 39	20	14	16	17	19	21	9 6
30	36 50	37 32	38 15	38 58	39 41	40 24	41 6	41 49	42 32	30	22	23	24	26	27	
40	36 43	37 26	38 9	38 51	39 34	40 17	40 59	41 42	42 25	40	29	30	31	33	34	
50	36 37	37 20	38 2	38 45	39 27	40 10	40 53	41 35	42 18	50	36	37	39	40	41	
45 0	36 31	37 13	37 56	38 38	39 21	40 3	40 46	41 28	42 11	0	0	1	3	4	6	
10	36 25	37 7	37 49	38 32	39 14	39 56	40 39	41 21	42 3	10	7	8	10	11	13	
20	36 19	37 1	37 43	38 25	39 7	39 50	40 32	41 14	41 56	20	14	15	17	18	20	
30	36 12	36 54	37 36	38 19	39 1	39 43	40 25	41 7	41 49	30	21	22	24	25	27	
40	36 6	36 48	37 30	38 12	38 54	39 36	40 18	41 0	41 42	40	28	29	31	32	34	
50	36 0	36 42	37 23	38 5	38 47	39 29	40 11	40 52	41 34	50	35	36	38	39	41	
46 0	35 53	36 35	37 17	37 59	38 40	39 22	40 4	40 45	41 27	0	0	1	3	4	6	
10	35 47	36 29	37 10	37 52	38 33	39 15	39 56	40 38	41 20	10	7	8	10	11	12	
20	35 41	36 22	37 4	37 45	38 26	39 8	39 49	40 31	41 12	20	14	15	17	18	19	
30	35 34	36 16	36 57	37 38	38 20	39 1	39 42	40 24	41 5	30	21	22	23	25	26	
40	35 28	36 9	36 50	37 32	38 13	38 54	39 35	40 16	40 57	40	28	29	30	32	33	
50	35 22	36 3	36 44	37 25	38 6	38 47	39 28	40 9	40 50	50	34	36	37	39	40	
47 0	35 15	35 56	36 37	37 18	37 59	38 40	39 21	40 2	40 43	0	0	1	3	4	5	
10	35 9	35 49	36 30	37 11	37 52	38 33	39 13	39 54	40 35	10	7	8	9	11	12	
20	35 2	35 43	36 23	37 4	37 45	38 25	39 6	39 47	40 28	20	14	15	16	18	19	
30	34 56	35 36	36 17	36 57	37 38	38 18	38 59	39 39	40 20	30	20	22	23	24	26	
40	34 49	35 29	36 10	36 50	37 31	38 11	38 52	39 32	40 12	40	27	28	30	31	32	
50	34 43	35 23	36 3	36 43	37 24	38 4	38 44	39 25	40 5	50	34	35	37	38	39	
48 0	34 36	35 16	35 56	36 36	37 17	37 57	38 37	39 17	39 57	0	0	1	3	4	5	
10	34 29	35 9	35 49	36 30	37 10	37 50	38 30	39 10	39 50	10	7	8	9	11	12	1′ 1′
20	34 23	35 3	35 43	36 23	37 2	37 42	38 22	39 2	39 42	20	13	15	16	17	19	2 1
30	34 16	34 56	35 36	36 16	36 55	37 35	38 15	38 55	39 34	30	20	21	23	24	25	3 2
40	34 10	34 49	35 29	36 8	36 48	37 28	38 7	38 47	39 27	40	27	28	29	30	32	4 3
50	34 3	34 42	35 22	36 1	36 41	37 20	38 0	38 39	39 19	50	33	34	36	37	38	5 4
49 0	33 56	34 36	35 15	35 54	36 34	37 13	37 52	38 32	39 11	0	0	1	3	4	5	6 4
10	33 50	34 29	35 8	35 47	36 27	37 6	37 45	38 24	39 3	10	6	8	9	10	12	7 5
20	33 43	34 22	35 1	35 40	36 19	36 58	37 37	38 17	38 56	20	13	14	16	17	19	8 6
30	33 36	34 15	34 54	35 33	36 12	36 51	37 30	38 9	38 48	30	20	21	22	23	25	9 7
40	33 29	34 8	34 47	35 26	36 5	36 44	37 22	38 1	38 40	40	26	27	29	30	31	
50	33 23	34 1	34 40	35 19	35 57	36 36	37 15	37 54	38 32	50	32	34	35	36	38	

CORRECTION OF THE MOON'S APPARENT ALTITUDE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°)

☽ App. Alt.	Horizontal Parallax 53′	54′	55′	56′	57′	58′	59′	60′	61′	″ of Par.	Corr. for ″ of Par add 0″	2″	4″	6″	8″	Cor. for ′ of Alt.
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	″	″	″	″	″	″	
50 0	33 16	33 54	34 33	35 11	35 50	36 29	37 7	37 46	38 24	0	0	1	3	4	5	
10	33 9	33 47	34 26	35 4	35 43	36 21	37 0	37 38	38 16	10	6	7	9	10	11	
20	33 2	33 40	34 19	34 57	35 35	36 14	36 52	37 30	38 9	20	13	14	15	17	18	
30	32 55	33 33	34 12	34 50	35 28	36 6	36 44	37 22	38 1	30	19	20	22	23	24	*sub.*
40	32 48	33 26	34 4	34 42	35 21	35 59	36 37	37 15	37 53	40	25	27	28	29	31	
50	32 42	33 19	33 57	34 35	35 13	35 51	36 29	37 7	37 45	50	32	33	34	36	37	1′ 1″
51 0	32 35	33 12	33 50	34 28	35 6	35 43	36 21	36 59	37 37	0	0	1	2	4	5	2 2
10	32 28	33 5	33 43	34 21	34 58	35 36	36 13	36 51	37 29	10	6	7	9	10	11	3 2
20	32 21	32 58	33 36	34 13	34 51	35 28	36 6	36 43	37 21	20	12	14	15	16	17	4 3
30	32 14	32 51	33 29	34 6	34 43	35 21	35 58	36 35	37 13	30	19	20	21	22	24	5 4
40	32 7	32 44	33 21	33 59	34 36	35 13	35 50	36 27	37 5	40	25	26	28	29	30	6 4
50	32 0	32 37	33 14	33 51	34 28	35 5	35 42	36 19	36 57	50	31	32	34	35	36	7 5
52 0	31 53	32 30	33 7	33 44	34 21	34 58	35 35	36 11	36 48	0	0	1	2	4	5	8 6
10	31 46	32 23	32 59	33 36	34 13	34 50	35 27	36 3	36 40	10	6	7	9	10	11	9 7
20	31 39	32 15	32 52	33 29	34 5	34 42	35 19	35 55	36 32	20	12	13	15	16	17	
30	31 32	32 8	32 45	33 21	33 58	34 34	35 11	35 47	36 24	30	18	19	21	22	23	
40	31 25	32 1	32 37	33 14	33 50	34 27	35 3	35 39	36 16	40	24	26	27	28	29	
50	31 17	31 54	32 30	33 6	33 43	34 19	34 55	35 31	36 8	50	30	32	33	34	35	
53 0	31 10	31 47	32 23	32 59	33 35	34 11	34 47	35 23	35 59	0	0	1	2	4	5	
10	31 3	31 39	32 15	32 51	33 27	34 3	34 39	35 15	35 51	10	6	7	8	10	11	1′ 1″
20	30 56	31 32	32 8	32 44	33 19	33 55	34 31	35 7	35 43	20	12	13	14	15	17	2 2
30	30 49	31 25	32 0	32 36	33 12	33 47	34 23	34 59	35 35	30	18	19	20	21	23	3 2
40	30 42	31 17	31 53	32 28	33 4	33 40	34 15	34 51	35 26	40	24	25	26	27	29	4 3
50	30 35	31 10	31 45	32 21	32 56	33 32	34 7	34 42	35 18	50	30	31	32	33	35	5 4
54 0	30 27	31 3	31 38	32 13	32 48	33 24	33 59	34 34	35 10	0	0	1	2	3	5	6 5
10	30 20	30 55	31 30	32 6	32 41	33 16	33 51	34 26	35 1	10	6	7	8	9	10	7 6
20	30 13	30 48	31 23	31 58	32 33	33 8	33 43	34 18	34 53	20	12	13	14	15	16	8 6
30	30 6	30 40	31 15	31 50	32 25	33 0	33 35	34 10	34 44	30	17	19	20	21	22	9 7
40	29 58	30 33	31 8	31 42	32 17	32 52	33 27	34 1	34 36	40	23	24	26	27	28	
50	29 51	30 26	31 0	31 35	32 9	32 44	33 18	33 53	34 28	50	29	30	31	32	34	
55 0	29 44	30 18	30 53	31 27	32 1	32 36	33 10	33 45	34 19	0	0	1	2	3	5	
10	29 36	30 11	30 45	31 19	31 54	32 28	33 2	33 36	34 11	10	6	7	8	9	10	
20	29 29	30 3	30 37	31 11	31 46	32 20	32 54	33 28	34 2	20	11	12	14	15	16	
30	29 22	29 56	30 30	31 4	31 38	32 12	32 46	33 20	33 54	30	17	18	19	20	22	
40	29 14	29 48	30 22	30 56	31 30	32 3	32 37	33 11	33 45	40	23	24	25	26	27	1′ 1″
50	29 7	29 41	30 14	30 48	31 22	31 55	32 29	33 3	33 37	50	28	29	31	32	33	2 2
56 0	28 59	29 33	30 7	30 40	31 14	31 47	32 21	32 54	33 28	0	0	1	2	3	4	3 2
10	28 52	29 25	29 59	30 32	31 6	31 39	32 12	32 46	33 19	10	6	7	8	9	10	4 3
20	28 45	29 18	29 51	30 24	30 58	31 31	32 4	32 37	33 11	20	11	12	13	14	15	5 4
30	28 37	29 10	29 43	30 16	30 50	31 23	31 56	32 29	33 2	30	17	18	19	20	21	6 5
40	28 30	29 3	29 36	30 9	30 42	31 15	31 48	32 20	32 53	40	22	23	24	25	26	7 6
50	28 22	28 55	29 28	30 1	30 33	31 6	31 39	32 12	32 45	50	28	29	30	31	32	8 6
57 0	28 15	28 47	29 20	29 53	30 25	30 58	31 31	32 3	32 36	0	0	1	2	3	4	9 7
10	28 7	28 40	29 12	29 45	30 17	30 50	31 22	31 55	32 27	10	5	7	8	9	10	
20	28 0	28 32	29 4	29 37	30 9	30 42	31 14	31 46	32 19	20	11	12	13	14	15	
30	27 52	28 24	28 56	29 29	30 1	30 33	31 5	31 38	32 10	30	16	17	18	19	20	
40	27 44	28 17	28 49	29 21	29 53	30 25	30 57	31 29	32 1	40	21	22	23	24	26	
50	27 37	28 9	28 41	29 13	29 45	30 17	30 49	31 20	31 52	50	27	28	29	30	31	
58 0	27 29	28 1	28 33	29 5	29 36	30 8	30 40	31 12	31 44	0	0	1	2	3	4	1′ 1″
10	27 22	27 53	28 25	28 57	29 28	30 0	30 32	31 3	31 35	10	5	6	7	8	9	2 2
20	27 14	27 45	28 17	28 48	29 20	29 51	30 23	30 55	31 26	20	10	11	13	14	15	3 2
30	27 6	27 38	28 9	28 40	29 12	29 43	30 14	30 46	31 17	30	16	17	18	19	20	4 3
40	26 59	27 30	28 1	28 32	29 3	29 35	30 6	30 37	31 8	40	21	22	23	24	25	5 4
50	26 51	27 22	27 53	28 24	28 55	29 26	29 57	30 28	30 59	50	26	27	28	29	30	6 5
59 0	26 43	27 14	27 45	28 16	28 47	29 18	29 49	30 20	30 51	0	0	1	2	3	4	7 6
10	26 36	27 6	27 37	28 8	28 39	29 9	29 40	30 11	30 42	10	5	6	7	8	9	8 7
20	26 28	26 58	27 29	28 0	28 30	29 1	29 32	30 2	30 33	20	10	11	12	13	14	9 7
30	26 20	26 51	27 21	27 52	28 22	28 52	29 23	29 53	30 24	30	15	16	17	18	19	
40	26 12	26 43	27 13	27 43	28 14	28 44	29 14	29 45	30 15	40	20	21	22	23	24	
50	26 5	26 35	27 5	27 35	28 5	28 35	29 6	29 36	[illegible]	50	25	26	27	28	29	

CORRECTION OF THE MOON'S APPARENT ALTITUDE

(Barometer, 30 Inches Fahrenheit's Thermometer, 50°)

☽ App. Alt	Horizontal Parallax 53'	54'	55'	56'	57'	58'	59'	60'	61'	" of Par.	Corr. for " of Par odd. 0"	2"	4"	6"	8"	Cor. for ' of Alt.
° '	' "	' "	' "	' "	' "	' "	' "	' "	' "	"	"	"	"	"	"	
60 0	25 57	26 27	26 57	27 27	27 57	28 27	28 57	29 27	29 57	0	0	1	2	3	4	
10	25 49	26 19	26 49	27 19	27 48	28 18	28 48	29 18	29 48	10	5	6	7	8	9	
20	25 41	26 11	26 41	27 10	27 40	28 10	28 39	29 9	29 39	20	10	11	12	13	14	
30	25 33	26 3	26 32	27 2	27 32	28 1	28 31	29 0	29 30	30	15	16	17	18	19	
40	25 26	25 55	26 24	26 54	27 23	27 53	28 22	28 51	29 21	40	20	21	22	23	24	
50	25 18	25 47	26 16	26 45	27 15	27 44	28 13	28 42	29 12	50	25	26	27	28	29	
61 0	25 10	25 39	26 8	26 37	27 6	27 35	28 4	28 34	29 3	0	0	1	2	3	4	
10	25 2	25 31	26 0	26 29	26 58	27 27	27 56	28 25	28 54	10	5	6	7	8	9	
20	24 54	25 23	25 52	26 20	26 49	27 18	27 47	28 16	28 44	20	10	10	11	12	13	
30	24 46	25 15	25 43	26 12	26 41	27 9	27 38	28 7	28 35	30	14	15	16	17	18	
40	24 38	25 7	25 35	26 4	26 32	27 1	27 29	27 58	28 26	40	19	20	21	22	23	
50	24 30	24 59	25 27	25 55	26 24	26 52	27 20	27 49	28 17	50	24	25	26	27	28	
62 0	24 22	24 51	25 19	25 47	26 15	26 43	27 11	27 40	28 8	0	0	1	2	3	4	
10	24 14	24 42	25 10	25 38	26 6	26 35	27 3	27 31	27 59	10	5	6	6	7	8	
20	24 6	24 34	25 2	25 30	25 58	26 26	26 54	27 22	27 49	20	9	10	11	12	13	
30	23 58	24 26	24 54	25 22	25 49	26 17	26 45	27 12	27 40	30	14	15	16	17	18	
40	23 50	24 18	24 46	25 13	25 41	26 8	26 36	27 3	27 31	40	18	19	20	21	22	
50	23 42	24 10	24 37	25 5	25 32	25 59	26 27	26 54	27 22	50	23	24	25	26	27	
63 0	23 34	24 2	24 29	24 56	25 23	25 51	26 18	26 45	27 12	0	0	1	2	3	4	
10	23 26	23 53	24 21	24 48	25 15	25 42	26 9	26 36	27 3	10	4	5	6	7	8	
20	23 18	23 45	24 12	24 39	25 6	25 33	26 0	26 27	26 54	20	9	10	11	12	13	sub.
30	23 10	23 37	24 4	24 31	24 57	25 24	25 51	26 18	26 44	30	13	14	15	16	17	' "
40	23 2	23 29	23 55	24 22	24 49	25 15	25 42	26 9	26 35	40	18	19	20	21	21	1 1
50	22 54	23 21	23 47	24 14	24 40	25 6	25 33	25 59	26 26	50	22	23	24	25	26	2 2
64 0	22 46	23 12	23 39	24 5	24 31	24 58	25 24	25 50	26 16	0	0	1	2	3	3	3 3
10	22 38	23 4	23 30	23 56	24 22	24 49	25 15	25 41	26 7	10	4	5	6	7	8	4 4
20	22 30	22 56	23 22	23 48	24 14	24 40	25 6	25 32	25 58	20	9	9	10	11	12	5 4
30	22 22	22 47	23 13	23 39	24 5	24 31	24 57	25 23	25 48	30	13	14	15	15	16	6 5
40	22 13	22 39	23 5	23 31	23 56	24 22	24 48	25 13	25 39	40	17	18	19	20	21	7 6
50	22 5	22 31	22 56	23 22	23 47	24 13	24 38	25 4	25 29	50	22	22	23	24	25	8 7
65 0	21 57	22 22	22 48	23 13	23 39	24 4	24 29	24 55	25 20	0	0	1	2	2	3	9 8
10	21 49	22 14	22 39	23 5	23 30	23 55	24 20	24 45	25 11	10	4	5	6	7	7	
20	21 41	22 6	22 31	22 56	23 21	23 46	24 11	24 36	25 1	20	8	9	10	11	12	
30	21 33	21 57	22 22	22 47	23 12	23 37	24 2	24 27	24 52	30	12	13	14	15	16	
40	21 24	21 49	22 14	22 39	23 3	23 28	23 53	24 17	24 42	40	17	17	18	19	20	
50	21 16	21 41	22 5	22 30	22 54	23 19	23 44	24 8	24 33	50	21	21	22	23	24	
66 0	21 8	21 32	21 57	22 21	22 46	23 10	23 34	23 59	24 23	0	0	1	2	2	3	
10	21 0	21 24	21 49	22 12	22 37	23 1	23 25	23 49	24 14	10	4	5	6	6	7	
20	20 51	21 15	21 40	22 4	22 28	22 52	23 16	23 40	24 4	20	8	9	10	10	11	
30	20 43	21 7	21 31	21 55	22 19	22 43	23 7	23 31	23 55	30	12	13	14	14	15	
40	20 35	20 59	21 22	21 46	22 10	22 34	22 57	23 21	23 45	40	16	17	18	18	19	
50	20 27	20 50	21 14	21 37	22 1	22 25	22 48	23 12	23 35	50	20	21	21	22	23	
67 0	20 18	20 42	21 5	21 29	21 52	22 15	22 39	23 2	23 26	0	0	1	2	2	3	
10	20 10	20 33	20 56	21 20	21 43	22 6	22 30	22 53	23 16	10	4	5	5	6	7	
20	20 2	20 25	20 48	21 11	21 34	21 57	22 20	22 43	23 7	20	8	8	9	10	11	
30	19 53	20 16	20 39	21 2	21 25	21 48	22 11	22 34	22 57	30	11	12	13	14	14	
40	19 45	20 8	20 30	20 53	21 16	21 39	22 2	22 24	22 47	40	15	16	17	18	18	
50	19 36	19 59	20 22	20 44	21 7	21 30	21 52	22 15	22 38	50	19	20	21	21	22	
68 0	19 28	19 51	20 13	20 36	20 58	21 21	21 43	22 5	22 28	0	0	1	2	2	3	
10	19 20	19 42	20 4	20 27	20 49	21 11	21 34	21 56	22 18	10	4	4	5	6	7	
20	19 11	19 33	19 56	20 18	20 40	21 2	21 24	21 46	22 9	20	7	8	9	10	10	
30	19 3	19 25	19 47	20 9	20 31	20 53	21 15	21 37	21 59	30	11	12	12	13	14	
40	18 54	19 16	19 38	20 0	20 22	20 44	21 5	21 27	21 49	40	15	15	16	17	17	
50	18 46	19 8	19 29	19 51	20 13	20 34	20 56	21 18	21 39	50	18	19	20	20	21	
69 0	18 38	18 59	19 21	19 42	20 4	20 25	20 47	21 8	21 30	0	0	1	1	2	3	
10	18 29	18 50	19 12	19 33	19 54	20 16	20 37	20 59	21 20	10	4	4	5	6	6	
20	18 21	18 42	19 3	19 24	19 45	20 7	20 28	20 49	21 10	20	7	8	8	9	10	
30	18 12	18 33	18 54	19 15	19 36	19 57	20 18	20 39	21 0	30	11	11	12	13	13	
40	18 4	18 25	18 45	19 6	19 27	19 48	20 9	20 30	20 51	40	14	15	15	16	17	
50	17 55	18 16	18 37	18 57	19 18	19 39	19 59	20 20	20 41	50	18	18	15	20	20	

CORRECTION OF THE MOON'S APPARENT ALTITUDE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°)

App. Alt.	Horizontal Parallax 53′	54′	55′	56′	57′	58′	59′	60′	61′	″ of Par.	Corr. for ″ of Par. add. 0″	2″	4″	6″	8″
° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	″	″	″	″	″	″
70 0	17 47	18 7	18 28	18 48	19 9	19 29	19 50	20 10	20 31	0	0	1	1	2	3
10	17 38	17 59	18 19	18 39	19 0	19 20	19 40	20 1	20 21	10	3	4	5	5	6
20	17 30	17 50	18 10	18 30	18 51	19 11	19 31	19 51	20 11	20	7	7	8	9	9
30	17 21	17 41	18 1	18 21	18 41	19 1	19 21	19 41	20 1	30	10	11	11	12	13
40	17 13	17 33	17 52	18 12	18 32	18 52	19 12	19 32	19 52	40	13	14	15	15	16
50	17 4	17 24	17 44	18 3	18 23	18 43	19 2	19 22	19 42	50	17	17	18	19	19
71 0	16 56	17 15	17 35	17 54	18 14	18 33	18 53	19 12	19 32	0	0	1	1	2	3
10	16 47	17 6	17 26	17 45	18 4	18 24	18 43	19 3	19 22	10	3	4	4	5	6
20	16 38	16 58	17 17	17 36	17 55	18 15	18 34	18 53	19 12	20	6	7	8	8	9
30	16 30	16 49	17 8	17 27	17 46	18 5	18 24	18 43	19 2	30	10	10	11	11	12
40	16 21	16 40	16 59	17 18	17 37	17 56	18 15	18 33	18 52	40	13	13	14	15	15
50	16 13	16 31	16 50	17 9	17 28	17 46	18 5	18 24	18 42	50	16	16	17	18	18
72 0	16 4	16 23	16 41	17 0	17 18	17 37	17 55	18 14	18 32	0	0	1	1	2	2
10	15 55	16 14	16 32	16 51	17 9	17 27	17 46	18 4	18 22	10	3	4	4	5	5
20	15 47	16 5	16 23	16 41	17 0	17 18	17 36	17 54	18 13	20	6	7	7	8	8
30	15 38	15 56	16 14	16 32	16 50	17 8	17 26	17 44	18 3	30	9	10	10	11	11
40	15 29	15 47	16 5	16 23	16 41	16 59	17 17	17 35	17 53	40	12	13	13	14	14
50	15 21	15 39	15 56	16 14	16 32	16 49	17 7	17 25	17 43	50	15	16	16	17	17
73 0	15 12	15 30	15 47	16 5	16 22	16 40	16 57	17 15	17 33	0	0	1	1	2	2
10	15 3	15 21	15 38	15 56	16 13	16 30	16 48	17 5	17 23	10	3	3	4	5	5
20	14 55	15 12	15 29	15 46	16 4	16 21	16 38	16 55	17 13	20	6	6	7	7	8
30	14 46	15 3	15 20	15 37	15 54	16 11	16 28	16 45	17 3	30	9	9	10	10	11
40	14 37	14 54	15 11	15 28	15 45	16 2	16 19	16 36	16 52	40	11	12	12	13	14
50	14 29	14 45	15 2	15 19	15 36	15 52	16 9	16 26	16 42	50	14	15	15	16	16
74 0	14 20	14 37	14 53	15 10	15 26	15 43	15 59	16 16	16 32	0	0	1	1	2	2
10	14 11	14 28	14 44	15 0	15 17	15 33	15 50	16 6	16 22	10	3	3	4	4	5
20	14 3	14 19	14 35	14 51	15 7	15 24	15 40	15 56	16 12	20	5	6	6	7	7
30	13 54	14 10	14 26	14 42	14 58	15 14	15 30	15 46	16 2	30	8	9	9	10	10
40	13 45	14 1	14 17	14 33	14 49	15 4	15 20	15 36	15 52	40	11	11	12	12	13
50	13 36	13 52	14 8	14 24	14 39	14 55	15 11	15 26	15 42	50	13	14	14	15	15
75 0	13 28	13 43	13 59	14 14	14 30	14 45	15 1	15 16	15 32	0	0	1	1	2	2
10	13 19	13 34	13 50	14 5	14 20	14 36	14 51	15 6	15 22	10	3	3	4	4	5
20	13 10	13 25	13 41	13 56	14 11	14 26	14 41	14 56	15 12	20	5	6	6	7	7
30	13 1	13 16	13 31	13 46	14 1	14 16	14 32	14 47	15 2	30	8	8	9	9	10
40	12 53	13 7	13 22	13 37	13 52	14 7	14 22	14 37	14 51	40	10	11	11	12	12
50	12 44	12 58	13 13	13 28	13 43	13 57	14 12	14 27	14 41	50	13	13	14	14	15
76 0	12 35	12 50	13 4	13 19	13 33	13 48	14 2	14 17	14 31	0	0	0	1	1	2
10	12 26	12 41	12 55	13 9	13 24	13 38	13 52	14 7	14 21	10	2	3	3	4	4
20	12 17	12 32	12 46	13 0	13 14	13 28	13 42	13 57	14 11	20	5	5	6	6	7
30	12 9	12 23	12 37	12 51	13 5	13 19	13 33	13 47	14 1	30	7	7	8	8	9
40	12 0	12 14	12 27	12 41	12 55	13 9	13 23	13 37	13 50	40	9	10	10	11	11
50	11 51	12 5	12 18	12 32	12 46	12 59	13 13	13 27	13 40	50	12	12	13	13	14
77 0	11 42	11 56	12 9	12 23	12 36	12 50	13 3	13 17	13 30	0	0	0	1	1	2
10	11 33	11 47	12 0	12 13	12 27	12 40	12 53	13 6	13 20	10	2	3	3	4	4
20	11 24	11 37	11 51	12 4	12 17	12 30	12 43	12 56	13 10	20	4	5	5	6	6
30	11 15	11 28	11 41	11 54	12 7	12 20	12 33	12 46	12 59	30	7	7	7	8	8
40	11 7	11 19	11 32	11 45	11 58	12 11	12 24	12 36	12 49	40	9	9	10	10	10
50	10 58	11 10	11 23	11 36	11 48	12 1	12 14	12 26	12 39	50	11	11	12	12	13
78 0	10 49	11 1	11 14	11 26	11 39	11 51	12 4	12 16	12 29	0	0	0	1	1	2
10	10 40	10 52	11 5	11 17	11 29	11 42	11 54	12 6	12 19	10	2	2	3	3	4
20	10 31	10 43	10 55	11 8	11 20	11 32	11 44	11 56	12 8	20	4	4	5	5	6
30	10 22	10 34	10 46	10 58	11 10	11 22	11 34	11 46	11 58	30	6	6	7	7	8
40	10 13	10 25	10 37	10 49	11 1	11 12	11 24	11 36	11 48	40	8	8	9	9	10
50	10 5	10 16	10 28	10 39	10 51	11 3	11 14	11 26	11 38	50	10	10	11	11	12
79 0	9 56	10 7	10 19	10 30	10 41	10 53	11 4	11 16	11 27	0	0	0	1	1	1
10	9 47	9 58	10 9	10 21	10 32	10 43	10 54	11 6	11 17	10	2	2	3	3	3
20	9 38	9 49	10 0	10 11	10 22	10 33	10 44	10 56	11 7	20	4	4	4	5	5
30	9 29	9 40	9 51	10 2	10 13	10 24	10 34	10 45	10 56	30	5	6	6	7	7
40	9 20	9 31	9 41	9 52	10 3	10 14	10 25	10 35	10 46	40	7	8	8	8	9
50	9 11	9 22	9 32	9 43	9 53	10 4	10 15	10 25	10 36	50	9	9	10	10	11

Cor. for ′ of Alt.

sub.

′	″
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

CORRECTION OF THE MOON'S APPARENT ALTITUDE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°)

☽ App. Alt.	Horizontal Parallax									" of Par.	Corr. for " of Par. *add.*					Cor. for ' of Alt.
	53'	54'	55'	56'	57'	58'	59'	60'	61'		0"	2"	4"	6"	8"	
° '	' "	' "	' "	' "	' "	' "	' "	' "	' "	"	"	"	"	"	"	
80 0	9 2	9 12	9 23	9 33	9 44	9 54	10 5	10 15	10 25	0	0	0	1	1	1	
10	8 53	9 3	9 14	9 24	9 34	9 44	9 55	10 5	10 15	10	2	2	2	3	3	
20	8 44	8 54	9 4	9 14	9 24	9 35	9 45	9 55	10 5	20	3	4	4	4	5	
30	8 35	8 45	8 55	9 5	9 15	9 25	9 35	9 45	9 54	30	5	5	6	6	6	
40	8 26	8 36	8 46	8 55	9 5	9 15	9 25	9 34	9 44	40	7	7	7	8	8	
50	8 17	8 27	8 36	8 46	8 56	9 5	9 15	9 24	9 34	50	8	9	9	9	10	
81 0	8 8	8 18	8 27	8 37	8 46	8 55	9 5	9 14	9 24	0	0	0	1	1	1	
10	7 59	8 9	8 18	8 27	8 36	8 45	8 55	9 4	9 13	10	1	2	2	2	3	
20	7 50	7 59	8 9	8 18	8 27	8 36	8 45	8 54	9 3	20	3	3	4	4	4	
30	7 41	7 50	7 59	8 8	8 17	8 26	8 35	8 44	8 52	30	4	5	5	5	6	
40	7 32	7 41	7 50	7 59	8 7	8 16	8 25	8 33	8 42	40	6	6	7	7	7	
50	7 24	7 32	7 41	7 49	7 58	8 6	8 15	8 23	8 32	50	7	8	8	8	9	
82 0	7 14	7 23	7 31	7 40	7 48	7 56	8 5	8 13	8 21	0	0	0	1	1	1	
10	7 5	7 14	7 22	7 30	7 38	7 46	7 55	8 3	8 11	10	1	2	2	2	2	
20	6 57	7 5	7 13	7 21	7 29	7 37	7 45	7 53	8 1	20	3	3	3	3	4	
30	6 48	6 55	7 3	7 11	7 19	7 27	7 34	7 42	7 50	30	[illegible]	4	4	5	5	
40	6 38	6 46	6 54	7 1	7 9	7 17	7 24	7 32	7 40	40	5	5	6	6	6	
50	6 29	6 37	6 44	6 52	6 59	7 7	7 14	7 22	7 29	50	6	7	7	7	8	*sub.*
83 0	6 20	6 28	6 35	6 42	6 50	6 57	7 4	7 12	7 19	0	0	0	0	1	1	1' 1"
10	6 11	6 19	6 26	6 33	6 40	6 47	6 54	7 1	7 9	10	1	1	2	2	2	2 2
20	6 2	6 9	6 16	6 23	6 30	6 37	6 44	6 51	6 58	20	2	2	3	3	3	3 3
30	5 53	6 0	6 7	6 14	6 21	6 27	6 34	6 41	6 48	30	3	4	4	4	4	4 4
40	5 44	5 51	5 58	6 4	6 11	6 18	6 24	6 31	6 37	40	5	5	5	5	5	5 5
50	5 35	5 42	5 48	5 55	6 1	6 8	6 14	6 21	6 27	50	6	6	6	6	7	6 6
84 0	5 26	5 33	5 39	5 45	5 51	5 58	6 4	6 10	6 17	0	0	0	0	0	1	7 7
10	5 17	5 23	5 30	5 36	5 42	5 48	5 54	6 0	6 6	10	1	1	1	1	2	8 8
20	5 8	5 14	5 20	5 26	5 32	5 38	5 44	5 50	5 56	20	2	2	2	2	3	9 9
30	4 59	5 5	5 11	5 17	5 22	5 28	5 34	5 40	5 45	30	3	3	3	3	4	
40	4 50	4 56	5 1	5 7	5 13	5 18	5 24	5 29	5 35	40	4	4	4	4	5	
50	4 41	4 47	4 52	4 57	5 3	5 8	5 14	5 19	5 24	50	5	5	5	5	6	
85 0	4 32	4 37	4 43	4 48	4 53	4 58	5 4	5 9	5 14	0	0	0	0	0	1	
10	4 23	4 28	4 33	4 38	4 43	4 48	4 53	4 58	5 4	10	1	1	1	1	1	
20	4 14	4 19	4 24	4 29	4 34	4 38	4 43	4 48	4 53	20	2	2	2	2	2	
30	4 5	4 10	4 14	4 19	4 24	4 28	4 33	4 38	4 43	30	2	2	3	3	3	
40	3 56	4 0	4 5	4 10	4 14	4 19	4 23	4 28	4 32	40	3	3	3	4	4	
50	3 47	3 51	3 56	4 0	4 4	4 9	4 13	4 17	4 22	50	4	4	4	4	5	
86 0	3 38	3 42	3 46	3 50	3 55	3 59	4 3	4 7	4 11	0	0	0	0	0	0	
10	3 29	3 33	3 37	3 41	3 45	3 49	3 53	3 57	4 1	10	1	1	1	1	1	
20	3 20	3 23	3 27	3 31	3 35	3 39	3 43	3 47	3 50	20	1	1	1	2	2	
30	3 11	3 14	3 18	3 22	3 25	3 29	3 33	3 36	3 40	30	2	2	2	2	2	
40	3 2	3 5	3 9	3 12	3 15	3 19	3 22	3 26	3 29	40	2	3	3	3	3	
50	2 53	2 56	2 59	3 2	3 6	3 9	3 12	3 16	3 19	50	3	3	3	3	4	
87 0	2 43	2 47	2 50	2 53	2 56	2 59	3 2	3 5	3 8	0	0	0	0	0	0	
10	2 34	2 37	2 40	2 43	2 46	2 49	2 52	2 55	2 58	10	0	1	1	1	1	
20	2 25	2 28	2 31	2 34	2 36	2 39	2 42	2 45	2 48	20	1	1	1	1	1	
30	2 16	2 19	2 21	2 24	2 27	2 29	2 32	2 35	2 37	30	1	1	1	2	2	
40	2 7	2 10	2 12	2 14	2 17	2 19	2 22	2 24	2 27	40	2	2	2	2	2	
50	1 58	2 0	2 3	2 5	2 7	2 9	2 12	2 14	2 16	50	2	2	2	2	3	
88 0	1 49	1 51	1 53	1 55	1 57	1 59	2 2	2 4	2 6	0	0	0	0	0	0	
10	1 40	1 42	1 44	1 46	1 48	1 50	1 51	1 53	1 55	10	0	0	0	0	0	
20	1 31	1 33	1 34	1 36	1 38	1 40	1 41	1 43	1 45	20	1	1	1	1	1	
30	1 22	1 23	1 25	1 26	1 28	1 30	1 31	1 33	1 34	30	1	1	1	1	1	
40	1 13	1 14	1 15	1 17	1 18	1 20	1 21	1 22	1 24	40	1	1	1	1	1	
50	1 4	1 5	1 6	1 7	1 9	1 10	1 11	1 12	1 13	50	1	1	1	1	2	
89 0	0 54	0 56	0 57	0 58	0 59	1 0	1 1	1 2	1 3	0	0	0	0	0	0	
10	0 45	0 46	0 47	0 48	0 49	0 50	0 51	0 52	0 52	10	0	0	0	0	0	
20	0 36	0 37	0 38	0 38	0 39	0 40	0 41	0 41	0 42	20	0	0	0	0	0	
30	0 27	0 28	0 28	0 29	0 29	0 30	0 30	0 31	0 31	30	0	0	0	0	0	
40	0 18	0 19	0 19	0 19	0 20	0 20	0 20	0 21	0 21	40	0	0	0	0	0	
50	0 9	0 9	0 9	0 10	0 10	0 10	0 10	0 10	0 10	50	1	1	1	1	1	

TABLE 40.

CORRESPONDING
HOR. PARALLAX AND SEMIDIAM. OF THE MOON.

H. Par.	Semid.	H. Par.	Semid	H. Par.	Semid
53′ 29″	14′ 36″	57′ 10″	15′ 36″	60′ 50″	16′ 36″
53 33	14 37	57 13	15 37	60 53	16 37
53 37	14 38	57 17	15 38	60 57	16 38
53 40	14 39	57 21	15 39	61 1	16 39
53 44	14 40	57 24	15 40	61 4	16 40
53 48	14 41	57 28	15 41	61 8	16 41
53 51	14 42	57 32	15 42	61 12	16 42
53 55	14 43	57 35	15 43	61 15	16 43
53 59	14 44	57 39	15 44	61 19	16 44
54 3	14 45	57 43	15 45	61 23	16 45
54 6	14 46	57 46	15 46	61 26	16 46
54 10	14 47	57 50	15 47	61 30	16 47
54 14	14 48	57 54	15 48	61 34	16 48
54 17	14 49	57 57	15 49	61 37	16 49
54 21	14 50	58 1	15 50	61 41	16 50
54 25	14 51	58 5	15 51		
54 28	14 52	58 8	15 52		
54 32	14 53	58 12	15 53		
54 36	14 54	58 16	15 54		
54 39	14 55	58 19	15 55		
54 43	14 56	58 23	15 56		
54 47	14 57	58 27	15 57		
54 50	14 58	58 30	15 58		
54 54	14 59	58 34	15 59		
54 58	15 0	58 38	16 0		
55 1	15 1	58 41	16 1		
55 5	15 2	58 45	16 2		
55 9	15 3	58 49	16 3		
55 12	15 4	58 52	16 4		
55 16	15 5	58 56	16 5		
55 20	15 6	59 0	16 6		
55 23	15 7	59 3	16 7		
55 27	15 8	59 7	16 8		
55 31	15 9	59 11	16 9		
55 34	15 10	59 14	16 10		
55 38	15 11	59 18	16 11		
55 42	15 12	59 22	16 12		
55 45	15 13	59 25	16 13		
55 49	15 14	59 29	16 14		
55 53	15 15	59 33	16 15		
55 56	15 16	59 36	16 16		
56 0	15 17	59 40	16 17		
56 4	15 18	59 44	16 18		
56 7	15 19	59 47	16 19		
56 11	15 20	59 51	16 20		
56 15	15 21	59 55	16 21		
56 18	15 22	59 58	16 22		
56 22	15 23	60 2	16 23		
56 26	15 24	60 6	16 24		
56 29	15 25	60 9	16 25		
56 33	15 26	60 13	16 26		
56 37	15 27	60 17	16 27		
56 40	15 28	60 20	16 28		
56 44	15 29	60 24	16 29		
56 48	15 30	60 28	16 30		
56 51	15 31	60 31	16 31		
56 55	15 32	60 35	16 32		
56 59	15 33	60 39	16 33		
57 2	15 34	60 42	16 34		
57 6	15 35	60 46	16 35		

TABLE 41

CORRECTION

OF THE MOON'S EQUATORIAL PARALLAX FOR THE FIGURE OF THE EARTH.

Compression $\frac{1}{293}$, (Clarke)

Lat.	Horizontal Parallax				
	54′	56′	58′	60′	62′
0°	″·0	″·0	″·0	″·0	″·0
8	0·2	0·2	0·2	0·2	0·2
16	0·8	0·9	0·9	0·9	0·9
20	1·3	1·4	1·4	1·4	1·5
24	1·8	1·9	2·0	2·0	2·1
28	2·4	2·5	2·6	2·7	2·8
32	3·1	3·2	3·4	3·5	3·6
36	3·8	4·0	4·1	4·2	4·4
40	4·6	4·7	4·9	5·1	5·2
44	5·3	5·5	5·7	5·9	6·1
48	6·1	6·3	6·6	6·8	7·0
52	6·9	7·1	7·4	7·6	7·9
56	7·6	7·9	8·2	8·4	8·7
60	8·3	8·6	8·9	9·2	9·5
64	8·9	9·3	9·6	9·9	10·2
68	9·5	9·9	10·2	10·6	10·9
72	10·0	10·4	10·7	11·1	11·5
76	10·4	10·8	11·2	11·6	12·0
80	10·7	11·1	11·5	11·9	12·3

TABLE 42

AUGMENTATION OF THE MOON'S SEMIDIAMETER

App. Alt.	Semidiameter					
	14′	15′		16′		17′
	30″	0″	30″	0″	30″	0″
0°	0″·1	0″·1	0″·1	0″·1	0″·1	0″·1
2	0·6	0·6	0·7	0·7	0·8	0·8
4	1·0	1·1	1·2	1·3	1·4	1·5
6	1·5	1·6	1·7	1·9	2·0	2·1
8	2·0	2·1	2·2	2·4	2·5	2·7
10	2·4	2·7	2·8	3·0	3·2	3·3
12	2·9	3·2	3·3	3·5	3·7	4·0
14	3·4	3·6	3·8	4·1	4·4	4·6
16	3·9	4·1	4·4	4·7	5·0	5·2
18	4·3	4·6	4·9	5·2	5·5	5·9
21	4·9	5·3	5·7	6·0	6·4	6·7
24	5·6	6·0	6·4	6·8	7·2	7·7
27	6·2	6·7	7·2	7·6	8·1	8·6
30	6·9	7·4	7·9	8·4	8·9	9·4
33	7·5	8·0	8·6	9·1	9·6	10·3
36	8·0	8·6	9·2	9·8	10·4	11·1
39	8·6	9·2	9·9	10·5	11·1	11·8
42	9·1	9·8	10·4	11·2	11·8	12·6
45	9·7	10·3	11·0	11·8	12·5	13·3
48	10·2	10·9	11·6	12·4	13·1	14·0
51	10·6	11·3	12·1	12·9	13·7	14·6
54	11·1	11·8	12·6	13·5	14·3	15·2
57	11·5	12·3	13·1	14·0	14·8	15·7
63	12·2	13·0	13·9	14·8	15·7	16·7
70	12·7	13·7	14·7	15·7	16·6	17·6
78	13·3	14·3	15·3	16·3	17·3	18·4
90	13·5	14·6	15·6	16·7	17·6	18·6

TABLE 43

CORRECTION

FOR REDUCING THE TRUE ALTITUDE OF THE SUN OR A STAR TO THE APPARENT ALTITUDE

Alt.	Corr.	Alt.	Corr.
	sub.		*sub.*
5° 0′	0′ 16″	7° 30′	0′ 6″
5 20	0 15	8 0	0 5
5 40	0 12	9 0	0 3
6 0	0 11	10 0	0 2
6 20	0 9	15 0	0 1
6 40	0 8	25 0	0 0
7 0	0 7		

TABLE 44

CORRECTION

FOR REDUCING THE TRUE ALTITUDE OF THE MOON TO THE APPARENT ALTITUDE

Alt.	Horizontal Parallax		
	54′	58′	61′
	add.	*add.*	*add.*
5° 0′	1′ 14″	1′ 22″	1′ 28″
5 10	1 10	1 18	1 23
5 20	1 7	1 15	1 19
5 30	1 5	1 11	1 16
5 40	1 3	1 8	1 13
5 50	1 0	1 5	1 10
6 0	0 57	1 3	1 7
6 20	0 52	0 57	1 2
6 40	0 47	0 51	0 54
7 0	0 45	0 47	0 51
7 20	0 41	0 44	0 47
7 40	0 37	0 40	0 42
8 0	0 34	0 36	0 38
8 30	0 30	0 32	0 33
9 0	0 26	0 28	0 29
9 30	0 22	0 24	0 25
10 0	0 19	0 20	0 20
10 30	0 16	0 17	0 18
11 0	0 14	0 14	0 14
11 30	0 12	0 12	0 11
12 0	0 9	0 9	0 9
13 0	0 6	0 6	0 7
14 0	0 4	0 3	0 2
15 0	0 0	0 0	0 0
	sub.	*sub.*	*sub.*
16 0	0 0	0 2	0 3
17 0	0 3	0 4	0 6
18 0	0 5	0 6	0 8
20 0	0 8	0 9	0 11
22 0	0 10	0 14	0 15
24 0	0 13	0 15	0 18
26 0	0 15	0 17	0 19
28 0	0 17	0 20	0 21
30 0	0 18	0 22	0 24
34 0	0 20	0 24	0 27
40 0	0 23	0 27	0 30
50 0	0 24	0 27	0 30
60 0	0 21	0 24	0 27
65 0	0 18	0 21	0 23
70 0	0 16	0 18	0 20
74 0	0 13	0 16	0 18
78 0	0 10	0 12	0 13
80 0	0 8	0 10	0 11
82 0	0 6	0 8	0 9
84 0	0 5	0 6	0 6
86 0	0 4	0 4	0 4
88 0	0 2	0 2	0 2
90 0	0 0	0 0	0 0

TABLE 45

PARALLAX IN ALTITUDE OF A PLANET

Alt.	Planet's Horizontal Parallax											
	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	20″	30″
5°	1″0	2″0	3″0	4″0	5″0	6″0	7″0	8″0	9″0	10″0	19″9	29″9
10	1·0	2·0	2·9	3·9	4·9	5·9	6·9	7·9	8·9	9·8	19·7	29·5
15	1·0	2·0	2·9	3·8	4·8	5·8	6·8	7·7	8·7	9·7	19·3	29·0
20	0·9	1·9	2·8	3·7	4·6	5·6	6·5	7·5	8·5	9·4	18·8	28·2
25	0·9	1·9	2·7	3·6	4·5	5·4	6·3	7·3	8·2	9·1	18·1	27·2
30	0·9	1·8	2·6	3·5	4·3	5·2	6·1	7·0	7·8	8·7	17·3	26·0
35	0·8	1·6	2·5	3·3	4·1	4·9	5·7	6·6	7·4	8·2	16·4	24·6
40	0·8	1·5	2·3	3·1	3·8	4·6	5·4	6·1	6·9	7·7	15·3	23·0
45	0·7	1·4	2·1	2·8	3·5	4·2	4·9	5·7	6·4	7·1	14·1	21·2
50	0·7	1·3	2·0	2·5	3·2	3·9	4·5	5·1	5·8	6·4	12·9	19·3
55	0·6	1·1	1·7	2·3	2·8	3·4	4·0	4·6	5·2	5·7	11·5	17·2
60	0·5	1·0	1·5	2·0	2·5	3·0	3·5	4·0	4·5	5·0	10·0	15·0
62	0·5	0·9	1·4	1·9	2·3	2·8	3·3	3·8	4·2	4·7	9·4	14·1
64	0·4	0·9	1·3	1·8	2·2	2·6	3·1	3·5	3·9	4·4	8·8	13·1
66	0·4	0·8	1·2	1·6	2·0	2·4	2·8	3·3	3·7	4·1	8·1	12·2
68	0·4	0·7	1·1	1·5	1·8	2·2	2·6	3·0	3·4	3·7	7·5	11·2
70	0·3	0·7	1·0	1·4	1·7	2·1	2·4	2·7	3·1	3·4	6·8	10·3
72	0·3	0·6	0·9	1·2	1·5	1·9	2·2	2·5	2·8	3·1	6·2	9·3
74	0·3	0·6	0·8	1·1	1·3	1·7	1·9	2·2	2·5	2·7	5·5	8·3
76	0·2	0·5	0·7	0·9	1·2	1·5	1·7	1·9	2·2	2·4	4·8	7·3
78	0·2	0·4	0·6	0·8	1·0	1·2	1·4	1·7	1·9	2·1	4·2	6·2
80	0·2	0·3	0·5	0·7	0·8	1·0	1·2	1·4	1·6	1·7	3·5	5·2
82	0·1	0·3	0·4	0·6	0·7	0·8	1·0	1·1	1·2	1·4	2·8	4·2
84	0·1	0·2	0·3	0·4	0·5	0·6	0·7	0·8	0·9	1·0	2·1	3·1
86	0·1	0·1	0·2	0·3	0·3	0·4	0·5	0·6	0·6	0·7	1·4	2·1
88	0·0	0·1	0·1	0·1	0·1	0·2	0·2	0·3	0·3	0·3	0·7	1·0
90	0	0	0	0	0	0	0	0	0	0	0	0

AZIMUTH, AND CORRESPONDING CHANGE OF ALTITUDE IN 1m OF TIME

Lat.	Change of Altitude in 1m															
	0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′	11′	12′	13′	14′	15′
0°	0°	4°	8°	12°	15°	19°	24°	28°	32°	37°	42°	47°	53°	60°	69°	87°
1	0	4	8	12	15	19	24	28	32	37	42	47	53	60	69	87
4	0	4	8	12	15	20	24	28	32	37	42	47	53	60	69	
6	0	4	8	12	16	20	24	28	32	37	42	48	54	61	70	
8	0	4	8	12	16	20	24	28	33	37	42	48	54	61	71	
10	0	4	8	12	16	20	24	28	33	38	43	48	54	62	71	
11	0	4	8	12	16	20	24	28	33	38	43	48	55	62	72	
12	0	4	8	12	16	20	24	28	33	38	43	49	55	62	73	
13	0	4	8	12	16	20	24	29	33	38	43	49	55	63	73	
14	0	4	8	12	16	20	24	29	33	38	43	49	56	63	74	
15	0	4	8	12	16	20	24	29	34	38	44	49	56	64	75	
16	0	4	8	12	16	20	25	29	34	39	44	50	56	64	76	
17	0	4	8	12	16	20	25	29	34	39	44	50	57	65	77	
18	0	4	8	12	16	21	25	29	34	39	44	50	57	66	79	
19	0	4	8	12	16	21	25	30	34	39	45	51	58	66	81	
20	0	4	8	12	16	21	25	30	35	40	45	51	58	67	83	
21	0	4	8	12	17	21	25	30	35	40	46	52	59	68	89	
22	0	4	8	12	17	21	26	30	35	40	46	52	60	69		
23	0	4	8	13	17	21	26	30	35	41	46	53	60	70		
24	0	4	8	13	17	21	26	31	36	41	47	53	61	72		
25	0	4	8	13	17	22	26	31	36	41	47	54	62	73		
26	0	4	9	13	17	22	26	31	36	42	48	55	63	75		
27	0	4	9	13	17	22	27	32	37	42	48	55	64	77		
28	0	4	9	13	18	22	27	32	37	43	49	56	65	79		
29	0	4	9	13	18	22	27	32	37	43	50	57	66	82		
30	0	4	9	13	18	23	27	33	38	44	50	58	67			
31	0	4	9	13	18	23	28	33	38	44	51	59	69			
32	0	5	9	14	18	23	28	33	39	45	52	60	71			
33	0	5	9	14	19	23	28	34	39	46	53	61	73			
34	0	5	9	14	19	24	29	34	40	46	54	62	75			
35	0	5	9	14	19	24	29	35	41	47	54	64	78			
36	0	5	9	14	19	24	30	35	41	48	55	65	81			
37	0	5	10	14	19	25	30	36	42	49	57	67				
38	0	5	10	15	20	25	30	36	43	49	58	69				
39	0	5	10	15	20	25	31	37	43	51	59	71				
40	0	5	10	15	20	26	31	38	44	52	60	73				
41	0	5	10	15	21	26	32	38	45	53	62	76				
42	0	5	10	16	21	27	33	39	46	54	64	81				
43	0	5	10	16	21	27	33	40	47	55	66					
44	0	5	11	16	22	28	34	40	48	57	68					
45	0	5	11	16	22	28	34	41	49	58	71					
46	0	5	11	17	23	29	35	42	50	60	74					
47	0	6	11	17	23	29	36	43	51	62	78					
48	0	6	11	17	23	30	37	44	53	64	85					
49	0	6	12	18	24	31	38	45	54	66						
50	0	6	12	18	25	31	38	47	56	69						
51	0	6	12	19	25	32	39	48	58	72						
52	0	6	12	19	26	33	41	49	60	77						
53	0	6	13	19	26	34	42	51	62	85						
54	0	7	13	20	27	35	43	53	65							
55	0	7	13	20	28	36	44	54	68							
56	0	7	14	21	28	37	46	57	73							
57	0	7	14	22	29	38	47	59	78							
58	0	7	15	22	30	40	49	62								
59	0	7	15	23	31	40	51	65								
60	0	8	15	24	32	42	53	69								
61	0	8	16	24	33	43	56	74								
62	0	8	6	25	35	45	58	84								
63	0	8	17	26	36	47	62									
64	0	9	18	27	37	49	66									
65	0	9	1	28	39	52	70									
66	0	9	10	29	41	55	80									

LIMITS, AT SEA, OF THE

REDUCTION TO THE MERIDIAN.

Lat.	Declination of the *same* Name as the Lat.					
	0°	5°	10°	15°	20°	23°
0°	0h 0m	0h 3m	0h 5m	0h 8m	0h 11m	0h 14m
5	0 3	0 0	0 3	0 5	0 8	0 10
10	0 5	0 3	0 0	0 3	0 6	0 7
15	0 8	0 5	0 3	0 0	0 3	0 5
20	0 11	0 8	0 6	0 3	0 0	0 0
25	0 14	0 11	0 9	0 6	0 3	0 0
30	0 17	0 15	0 12	0 9	0 6	0 5
35	0 21	0 18	0 16	0 13	0 10	0 8
40	0 25	0 23	0 20	0 17	0 14	0 12
44	0 29	0 26	0 24	0 21	0 18	0 16
48	0 33	0 31	0 28	0 25	0 22	0 20
52	0 38	0 36	0 33	0 30	0 27	0 26
56	0 44	0 42	0 39	0 36	0 34	0 32
60	0 52	0 49	0 47	0 44	0 41	0 39
64	1 0	0 57	0 55	0 52	0 49	0 47
68	1 10	1 8	1 6	1 3	1 1	0 58

Lat.	Declination of *contrary* Name to the Lat.					
0	0 0	0 3	0 5	0 8	0 11	0 13
5	0 3	0 5	0 8	0 11	0 14	0 16
10	0 5	0 8	0 11	0 13	0 16	0 18
15	0 8	0 11	0 13	0 16	0 19	0 21
20	0 11	0 14	0 16	0 19	0 22	0 24
25	0 14	0 17	0 19	0 22	0 25	0 27
30	0 17	0 20	0 23	0 25	0 28	0 30
35	0 21	0 24	0 26	0 29	0 32	0 34
40	0 25	0 28	0 30	0 33	0 36	0 38
44	0 29	0 32	0 34	0 37	0 40	0 42
48	0 33	0 36	0 39	0 41	0 44	0 46
52	0 38	0 41	0 44	0 46	0 49	0 51
56	0 44	0 47	0 50	0 52	0 55	0 57
60	0 52	0 55	0 57	1 00	1 3	1 5
64	1 0	1 3	1 6	while visible.		
68	1 10	1 13	1 16			

TABLE 48

VALUE OF

THE REDUCTION,

AT WHICH THE 2nd REDn AMOUNTS TO 1′

Mer. Alt.	Reduc.	Mer. Alt.	Reduc
5°	4° 40′	45°	1° 23′
6	4 16	46	1 21
7	3 57	47	1 20
8	3 41	48	1 19
9	3 28	49	1 17
10	3 18	50	1 16
11	3 8	51	1 15
12	3 0	52	1 13
13	2 53	53	1 12
14	2 46	54	1 11
15	2 40	55	1 9
16	2 35	56	1 8
17	2 30	57	1 7
18	2 25	58	1 6
19	2 21	59	1 4
20	2 17	60	1 3
21	2 14	61	1 2
22	2 10	62	1 0
23	2 7	63	0 59
24	2 4	64	0 58
25	2 2	65	0 57
26	1 59	66	0 55
27	1 56	67	0 54
28	1 54	68	0 53
29	1 51	69	0 52
30	1 49	70	0 50
31	1 47	71	0 49
32	1 45	72	0 47
33	1 43	73	0 46
34	1 41	74	0 44
35	1 39	75	0 43
36	1 37	76	0 41
37	1 36	77	0 40
38	1 34	78	0 38
39	1 32	79	0 37
40	1 31	80	0 35
41	1 29	81	0 33
42	1 27	82	0 31
43	1 26	83	0 29
44	1 24	84	0 27

FOR COMPUTING THE REDUCTION TO THE MERIDIAN IN SECONDS

0 Hours

s.	0m	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	
0	0.0	2.0	7.8	17.7	31.4	49.1	70.7	96.2	125.7	159.0	196.3	237.5	282.7	60
1	0.0	2.0	8.0	17.9	31.7	49.4	71.1	96.6	126.2	159.6	197.0	238.3	283.5	59
2	0.0	2.1	8.1	18.1	31.9	49.7	71.5	97.1	126.7	160.2	197.6	239.0	284.2	58
3	0.0	2.2	8.2	18.3	32.2	50.1	71.9	97.6	127.2	160.8	198.3	239.7	285.0	57
4	0.0	2.2	8.4	18.5	32.5	50.4	72.3	98.1	127.8	161.4	198.9	240.4	285.8	56
5	0.0	2.3	8.5	18.7	32.7	50.7	72.7	98.5	128.3	162.0	195.6	241.2	286.6	55
6	0.0	2.4	8.7	18.9	33.0	51.1	73.1	99.0	128.8	162.6	200.3	241.9	287.4	54
7	0.0	2.4	8.8	19.1	33.3	51.4	73.5	99.4	129.4	163.2	200.9	242.6	288.2	53
8	0.0	2.5	8.9	19.3	33.5	51.7	73.9	99.9	129.9	163.8	201.6	243.3	289.0	52
9	0.0	2.6	9.1	19.5	33.8	52.1	74.3	100.4	130.4	164.4	202.2	244.1	289.8	51
10	0.0	2.7	9.2	19.7	34.1	52.4	74.7	100.8	131.0	165.0	202.9	244.8	290.6	50
11	0.1	2.7	9.4	19.9	34.4	52.7	75.1	101.3	131.5	165.6	203.6	245.5	291.4	49
12	0.1	2.8	9.5	20.1	34.6	53.1	75.5	101.8	132.0	166.2	204.2	246.2	292.2	48
13	0.1	2.9	9.6	20.3	34.9	53.4	75.9	102.3	132.6	166.8	204.9	247.0	293.0	47
14	0.1	3.0	9.8	20.5	35.2	53.8	76.3	102.7	133.1	167.4	205.6	247.7	293.8	46
15	0.1	3.1	9.9	20.7	35.5	54.1	76.7	103.2	133.6	168.0	206.3	248.5	294.6	45
16	0.1	3.1	10.1	20.9	35.7	54.5	77.1	103.7	134.2	168.6	206.9	249.2	295.4	44
17	0.2	3.2	10.2	21.2	36.0	54.8	77.5	104.2	134.7	169.2	207.6	249.9	296.2	43
18	0.2	3.3	10.4	21.4	36.3	55.1	77.9	104.6	135.3	169.8	208.3	250.7	297.0	42
19	0.2	3.4	10.5	21.6	36.6	55.5	78.3	105.1	135.8	170.4	208.9	251.4	297.8	41
20	0.2	3.5	10.7	21.8	36.9	55.8	78.8	105.6	136.4	171.0	209.6	252.2	298.6	40
21	0.3	3.6	10.8	22.0	37.2	56.2	79.2	106.1	136.9	171.6	210.3	252.9	299.4	39
22	0.3	3.7	11.0	22.3	37.4	56.5	79.6	106.6	137.4	172.2	211.0	253.6	300.2	38
23	0.3	3.8	11.1	22.5	37.7	56.9	80.0	107.0	138.0	172.9	211.6	254.4	301.0	37
24	0.3	3.8	11.3	22.7	38.0	57.3	80.4	107.5	138.5	173.5	212.3	255.1	301.8	36
25	0.3	3.9	11.5	22.9	38.3	57.6	80.8	108.0	139.1	174.1	213.0	255.9	302.6	35
26	0.4	4.0	11.6	23.1	38.6	58.0	81.3	108.5	139.6	174.7	213.7	256.6	303.5	34
27	0.4	4.1	11.8	23.4	38.9	58.3	81.7	109.0	140.2	175.3	214.4	257.4	304.3	33
28	0.4	4.2	11.9	23.6	39.2	58.7	82.1	109.5	140.7	175.9	215.1	258.[illegible]	305.1	32
29	0.5	4.3	12.1	23.8	39.5	59.0	82.5	110.0	141.3	176.6	215.8	258.9	305.9	31
30	0.5	4.4	12.3	24.0	39.8	59.4	83.0	110.4	141.8	177.2	216.4	259.6	306.7	30
31	0.5	4.5	12.4	24.3	40.1	59.8	83.4	110.9	142.4	177.8	217.1	260.4	307.5	29
32	0.6	4.6	12.6	24.5	40.3	60.1	83.8	111.4	143.0	178.4	217.8	261.1	308.4	28
33	0.6	4.7	12.8	24.7	40.6	60.5	84.2	111.9	143.5	179.0	218.5	261.9	309.2	27
34	0.6	4.8	12.9	25.0	40.9	60.8	84.7	112.4	144.1	179.7	219.2	262.6	310.0	26
35	0.7	4.9	13.1	25.2	41.2	61.2	85.1	112.9	144.6	180.3	219.9	263.4	310.8	25
36	0.7	5.0	13.3	25.4	41.5	61.6	85.5	113.4	145.2	180.9	220.6	264.1	311.6	24
37	0.7	5.1	13.4	25.7	41.8	61.9	86.0	113.9	145.8	181.6	221.3	264.9	312.5	23
38	0.8	5.2	13.6	25.9	42.1	62.3	86.4	114.4	146.3	182.2	222.0	265.7	313.3	22
39	0.8	5.3	13.8	26.2	42.5	62.7	86.8	114.9	146.9	182.8	222.7	266.4	314.2	21
40	0.9	5.4	14.0	26.4	42.8	63.0	87.3	115.4	147.5	183.4	223.4	267.2	315.0	20
41	0.9	5.6	14.1	26.6	43.1	63.4	87.7	115.9	148.0	184.1	224.1	267.9	315.8	19
42	1.0	5.7	14.3	26.9	43.4	63.8	88.1	116.4	148.6	184.7	224.8	268.7	316.6	18
43	1.0	5.8	14.5	27.1	43.7	64.2	88.6	116.9	149.2	185.4	225.5	269.5	317.4	17
44	1.1	5.9	14.7	27.4	44.0	64.5	89.0	117.4	149.7	186.0	226.2	270.2	318.3	16
45	2.1	6.0	14.8	27.6	44.3	64.9	89.5	117.9	150.3	186.6	226.9	271.0	319.1	15
46	1.2	6.1	15.0	27.9	44.6	65.3	89.9	118.4	150.9	187.3	227.6	271.8	319.9	14
47	1.2	6.2	15.2	28.1	44.9	65.7	90.3	118.9	151.5	187.9	228.3	272.6	320.8	13
48	1.3	6.4	15.4	28.3	45.2	66.0	90.8	119.5	152.0	188.5	229.0	273.3	321.6	12
49	1.3	6.5	15.6	28.6	45.5	66.4	91.2	120.0	152.6	189.2	229.7	274.1	322.4	11
50	1.4	6.6	15.8	28.8	45.9	66.8	91.7	120.5	153.2	189.8	230.4	274.9	323.3	10
51	1.4	6.7	15.9	29.1	46.2	67.2	92.1	121.0	153.8	190.5	231.1	275.6	324.1	9
52	1.5	6.8	16.1	29.4	46.5	67.6	92.6	121.5	154.4	191.1	231.8	276.4	325.0	8
53	1.5	7.0	16.3	29.6	46.8	68.0	93.0	122.0	154.9	191.8	232.5	277.2	325.8	7
54	1.6	7.1	16.5	29.9	47.1	68.3	93.5	122.5	155.5	192.4	233.3	278.0	326.7	6
55	1.6	7.2	16.7	30.1	47.5	68.7	93.9	123.1	156.1	193.1	234.0	278.9	327.5	5
56	1.7	7.3	16.9	30.4	47.8	69.1	94.4	123.6	156.7	193.7	234.7	279.5	328.4	4
57	1.8	7.5	17.1	30.6	48.1	69.5	94.8	124.1	157.3	194.4	235.4	280.3	329.2	3
58	1.8	7.6	17.3	30.9	48.4	69.9	95.3	124.6	157.8	195.0	236.1	281.1	330.0	2
59	1.9	7.7	17.5	31.1	48.8	70.3	95.7	125.1	158.4	195.7	236.8	281.9	330.9	1
60	2.0	7.8	17.7	31.4	49.1	70.7	96.2	125.7	159.0	196.3	237.5	282.7	331.8	0
	59m	58m	57m	56m	55m	54m	53m	52m	51m	50m	49m	48m	47m	s

11 Hours

FOR COMPUTING THE REDUCTION TO THE MERIDIAN IN SECONDS

0 Hours

s.	13m	14m	15m	16m	17m	18m	19m	20m	21m	22m	23m	24m	s.
0	331″8	384″7	441″6	502″5	567″1	635″8	708″3	784″9	865″3	949″6	1037″8	1129″9	60
1	332·6	385·6	442·6	503·5	568·2	636·9	709·5	786·2	866·6	951·0	1039·3	1131·4	59
2	333·4	386·5	443·6	504·6	569·3	638·1	710·8	787·5	868·0	952·4	1040·8	1133·0	58
3	334·3	387·5	444·6	505·6	570·4	639·3	712·1	788·8	869·4	953·8	1042·3	1134·6	57
4	335·2	388·4	445·6	506·7	571·6	640·5	713·4	790·1	870·8	955·3	1043·8	1136·2	56
5	336·0	389·3	446·5	507·7	572·7	641·7	714·6	791·4	872·1	956·7	1045·3	1137·8	55
6	336·9	390·2	447·5	508·8	573·8	642·9	715·9	792·7	873·5	958·2	1046·8	1139·3	54
7	337·7	391·1	448·5	509·8	574·9	644·1	717·1	794·0	874·9	959·6	1048·3	1140·9	53
8	338·6	392·1	449·5	510·9	576·1	645·3	718·4	795·4	876·3	961·1	1049·8	1142·5	52
9	339·4	393·0	450·5	511·9	577·2	646·4	719·6	796·7	877·6	962·5	1051·3	1144·0	51
10	340·3	393·9	451·5	513·0	578·3	647·6	720·9	798·0	879·0	963·9	1052·8	1145·6	50
11	341·2	394·8	452·5	514·0	579·4	648·8	722·1	799·3	880·4	965·4	1054·3	1147·2	49
12	342·0	395·8	453·5	515·1	580·6	650·0	723·4	800·7	881·8	966·9	1055·9	1148·8	48
13	342·9	396·7	454·5	516·1	581·7	651·2	724·6	802·0	883·2	968·3	1057·4	1150·4	47
14	343·7	397·6	455·5	517·2	582·8	652·4	725·9	803·3	884·6	969·8	1058·9	1152·0	46
15	344·6	398·6	456·5	518·3	583·9	653·6	727·1	804·6	886·0	971·2	1060·4	1153·6	45
16	345·5	399·5	457·5	519·4	585·1	654·8	728·4	806·0	887·4	972·7	1062·0	1155·2	44
17	346·3	400·5	458·5	520·4	586·2	656·0	729·6	807·3	888·8	974·1	1063·5	1156·8	43
18	347·2	401·4	459·5	521·4	587·3	657·2	730·9	808·6	890·2	975·5	1065·0	1158·3	42
19	348·1	402·3	460·5	522·5	588·4	658·4	732·2	809·9	891·6	977·0	1066·5	1159·9	41
20	349·0	403·3	461·5	523·5	589·6	659·6	733·5	811·3	893·0	978·5	1068·1	1161·5	40
21	349·8	404·2	462·5	524·6	590·7	660·8	734·7	812·6	894·4	979·9	1069·6	1163·1	39
22	350·7	405·1	463·5	525·7	591·9	662·0	736·0	813·9	895·8	981·4	1071·1	1164·7	38
23	351·6	406·0	464·5	526·8	593·0	663·2	737·2	815·2	897·2	982·9	1072·6	1166·3	37
24	352·5	407·0	465·5	527·9	594·1	664·4	738·5	816·6	898·6	984·4	1074·2	1167·9	36
25	353·3	408·0	466·5	528·9	595·2	665·6	739·7	817·9	900·0	985·8	1075·7	1169·5	35
26	354·2	408·9	467·5	530·0	596·4	666·8	741·0	819·2	901·4	987·3	1077·2	1171·1	34
27	355·1	409·9	468·5	531·1	597·5	668·0	742·3	820·5	902·8	988·8	1078·7	1172·7	33
28	356·0	410·8	469·5	532·2	598·7	669·2	743·6	821·9	904·2	990·3	1080·3	1174·8	32
29	356·9	411·7	470·5	533·2	599·8	670·4	744·8	823·2	905·6	991·8	1081·8	1175·9	31
30	357·7	412·7	471·5	534·3	601·0	671·6	746·1	824·6	907·0	993·2	1083·3	1177·5	30
31	358·6	413·6	472·6	535·4	602·1	672·8	747·4	825·9	908·4	994·7	1084·8	1179·1	29
32	359·5	414·6	473·6	536·5	603·3	674·1	748·7	827·3	909·8	996·2	1086·4	1180·7	28
33	360·3	415·6	474·6	537·5	604·4	675·3	749·9	828·6	911·2	997·6	1087·9	1182·3	27
34	361·2	416·6	475·6	538·6	605·6	676·5	751·2	829·9	912·6	999·1	1089·5	1183·9	26
35	362·1	417·5	476·6	539·7	606·7	677·7	752·5	831·2	914·0	1000·6	1091·0	1185·5	25
36	363·0	418·4	477·6	540·8	607·9	678·9	753·8	832·6	915·5	1002·1	1092·6	1187·1	24
37	363·9	419·4	478·7	541·9	609·0	680·1	755·0	833·9	916·9	1003·5	1094·1	1188·7	23
38	364·8	420·3	479·7	543·0	610·2	681·3	756·3	835·3	918·3	1005·0	1095·7	1190·3	22
39	365·7	421·3	480·7	544·1	611·3	682·5	757·6	836·6	919·7	1006·5	1097·2	1191·9	21
40	366·5	422·2	481·7	545·2	612·5	683·8	758·9	838·0	921·1	1008·0	1098·8	1193·5	20
41	367·5	423·2	482·8	546·2	613·6	685·0	760·2	839·3	922·5	1009·4	1100·3	1195·1	19
42	368·4	424·2	483·8	547·3	614·8	686·2	761·5	840·7	923·9	1010·9	1101·9	1196·7	18
43	369·3	425·1	484·8	548·4	615·9	687·4	762·8	842·0	925·3	1012·4	1103·4	1198·3	17
44	370·2	426·1	485·8	549·5	617·1	688·7	764·0	843·4	926·8	1013·9	1105·0	1199·9	16
45	371·1	427·0	486·9	550·6	618·2	689·9	765·3	844·7	928·2	1015·4	1106·5	1201·5	15
46	372·0	428·0	487·9	551·7	619·4	691·1	766·6	846·1	929·6	1016·9	1108·1	1203·1	14
47	372·9	429·0	488·9	552·8	620·5	692·3	767·9	847·5	931·0	1018·4	1109·6	1204·7	13
48	373·8	430·0	490·0	553·9	621·7	693·6	769·2	848·9	932·4	1019·9	1111·2	1206·4	12
49	374·7	430·9	491·0	555·0	622·8	694·8	770·5	850·2	933·8	1021·4	1112·7	1208·0	11
50	375·6	431·9	492·0	556·1	624·0	696·0	771·8	851·6	935·2	1022·8	1114·3	1209·6	10
51	376·5	432·8	493·1	557·2	625·2	697·2	773·1	852·9	936·6	1024·3	1115·8	1211·2	9
52	377·4	433·8	494·1	558·3	626·4	698·4	774·5	854·3	938·1	1025·8	1117·4	1212·0	8
53	378·3	434·8	495·2	559·4	627·5	699·6	775·8	855·6	939·5	1027·3	1118·9	1214·5	7
54	379·2	435·7	496·2	560·5	628·7	700·9	777·1	857·1	940·9	1028·8	1120·5	1216·1	6
55	380·2	436·7	497·2	561·6	629·9	702·2	778·4	858·4	942·3	1030·3	1122·0	1217·7	5
56	381·1	437·7	498·2	562·7	631·1	703·5	779·7	859·8	943·8	1031·8	1123·6	1218·4	4
57	382·0	438·7	499·2	563·8	632·2	704·7	781·0	861·1	945·2	1033·3	1125·1	1221·0	3
58	382·9	439·6	500·3	564·9	633·4	705·9	782·3	862·5	946·6	1034·8	1126·7	1222·6	2
59	383·8	440·6	501·4	566·0	634·6	707·1	783·6	863·9	948·1	1036·3	1128·3	1224·2	1
60	384·7	441·6	502·5	567·1	635·8	708·3	784·9	865·3	949·6	1037·8	1129·9	1225·9	0
	46m	45m	44m	43m	42m	41m	40m	39m	38m	37m	36m	35m	s.

11 Hours

TABLE 49

For Computing the REDN to the MERN in SECDS.

0 Hours

s.	25m	26m	27m	28m	29m	30m	
0	1225″9	1325″9	1429″7	1537″5	1649″0	1764″6	60
1	1227·5	1327·6	1431·4	1539·3	1650·9	1766·6	59
2	1229·2	1329·3	1433·2	1541·1	1652·8	1768·5	58
3	1230·8	1331·0	1434·9	1542·9	1654·7	1770·5	57
4	1232·5	1332·7	1436·7	1544·8	1656·6	1772·4	56
5	1234·1	1334·4	1438·5	1546·6	1658·5	1774·4	55
6	1235·7	1336·1	1440·3	1548·4	1660·4	1776·3	54
7	1237·3	1337·8	1442·1	1550·2	1662·3	1778·3	53
8	1239·0	1339·5	1443·9	1552·1	1664·2	1780·3	52
9	1240·6	1341·2	1445·6	1553·9	1666·1	1782·3	51
10	1242·3	1342·9	1447·4	1555·8	1668·0	1784·2	50
11	1243·9	1344·6	1449·2	1557·6	1669·9	1786·2	49
12	1245·6	1346·3	1451·0	1559·5	1671·9	1788·2	48
13	1247·2	1348·0	1452·8	1561·3	1673·8	1790·1	47
14	1248·9	1349·7	1454·5	1563·2	1675·7	1792·1	46
15	1250·5	1351·4	1456·3	1565·0	1677·6	1794·1	45
16	1252·2	1353·2	1458·1	1566·9	1679·5	1796·1	44
17	1253·8	1354·9	1459·9	1568·7	1681·4	1798·1	43
18	1255·5	1356·6	1461·6	1570·5	1683·3	1800·0	42
19	1257·1	1358·3	1463·4	1572·4	1685·2	1802·0	41
20	1258·8	1360·1	1465·2	1574·3	1687·2	1804·0	40
21	1260·4	1361·8	1466·9	1576·1	1689·1	1805·9	39
22	1262·1	1363·5	1468·7	1578·0	1691·0	1807·9	38
23	1263·7	1365·2	1470·5	1579·8	1692·9	1809·9	37
24	1265·4	1367·0	1472·3	1581·7	1694·8	1811·9	36
25	1267·0	1368·7	1474·0	1583·5	1696·7	1813·9	35
26	1268·7	1370·4	1475·9	1585·3	1698·6	1815·8	34
27	1270·3	1372·1	1477·7	1587·2	1700·5	1817·8	33
28	1272·0	1373·9	1479·5	1589·1	1702·5	1819·8	32
29	1273·7	1375·6	1481·3	1590·9	1704·4	1821·8	31
30	1275·4	1377·4	1483·1	1592·7	1706·3	1823·8	30
31	1277·1	1379·1	1484·9	1594·6	1708·2	1825·8	29
32	1278·8	1380·8	1486·7	1596·5	1710·2	1827·8	28
33	1280·4	1382·5	1488·5	1598·3	1712·1	1829·8	27
34	1282·1	1384·2	1490·3	1600·2	1714·0	1831·8	26
35	1283·8	1385·9	1492·1	1602·1	1715·9	1833·8	25
36	1285·5	1387·7	1493·9	1604·0	1717·9	1835·8	24
37	1287·1	1389·4	1495·7	1605·9	1719·8	1837·8	23
38	1288·8	1391·2	1497·5	1607·7	1721·7	1839·8	22
39	1290·5	1392·9	1499·3	1609·6	1723·6	1841·8	21
40	1292·2	1394·7	1501·1	1611·5	1725·6	1843·8	20
41	1293·8	1396·4	1502·9	1613·3	1727·5	1845·8	19
42	1295·5	1398·2	1504·7	1615·2	1729·5	1847·8	18
43	1297·2	1399·9	1506·5	1617·1	1731·5	1849·8	17
44	1298·9	1401·7	1508·4	1619·0	1733·4	1851·8	16
45	1300·5	1403·4	1510·2	1620·8	1735·3	1853·8	15
46	1302·2	1405·2	1512·0	1622·7	1737·2	1855·8	14
47	1303·9	1406·9	1513·8	1624·6	1739·2	1857·8	13
48	1305·6	1408·7	1515·6	1626·5	1741·2	1859·8	12
49	1307·3	1410·4	1517·4	1628·3	1743·1	1861·8	11
50	1309·0	1412·2	1519·2	1630·2	1745·1	1863·8	10
51	1310·7	1413·9	1521·0	1632·1	1747·0	1865·8	9
52	1312·4	1415·7	1522·9	1634·0	1749·0	1867·8	8
53	1314·1	1417·4	1524·7	1635·9	1750·9	1869·8	7
54	1315·7	1419·2	1526·5	1637·7	1752·9	1871·8	6
55	1317·4	1420·9	1528·3	1639·6	1754·8	1873·8	5
56	1319·1	1422·7	1530·2	1641·5	1756·8	1875·9	4
57	1320·8	1424·4	1532·0	1643·3	1758·7	1877·9	3
58	1322·5	1426·2	1533·8	1645·2	1760·7	1879·9	2
59	1324·2	1427·9	1535·6	1647·1	1762·6	1882·0	1
60	1325·9	1429·7	1537·5	1649·0	1764·6	1884·0	0
	34m	33m	32m	31m	30m	29m	s

11 Hours

TABLE 50

For Computing the 2d Reduction in Seconds

Hour Angle.	2nd Red.	Hour Angle.	2nd Red.
10m 0s	0″1	23m 50s	3″0
11 0	0·1	24 0	3·1
11 30	0·2	24 10	3·2
12 0	0·2	24 20	3·3
12 30	0·2	24 30	3·4
13 0	0·3	24 40	3·4
13 30	0·3	24 50	3·5
14 0	0·4	25 0	3·6
14 30	0·4	25 10	3·7
15 0	0·5	25 20	3·8
15 30	0·5	25 30	3·9
16 0	0·6	25 40	4·0
16 30	0·7	25 50	4·1
17 0	0·8	26 0	4·3
17 30	0·9	26 10	4·4
18 0	1·0	26 20	4·5
18 30	1·1	26 30	4·6
19 0	1·2	26 40	4·7
19 30	1·3	26 50	4·8
19 40	1·4	27 0	5·0
19 50	1·4	27 10	5·1
20 0	1·5	27 20	5·2
20 10	1·5	27 30	5·3
20 20	1·6	27 40	5·5
20 30	1·6	27 50	5·6
20 40	1·7	28 0	5·7
20 50	1·8	28 10	5·9
21 0	1·8	28 20	6·0
21 10	1·9	28 30	6·1
21 20	1·9	28 40	6·3
21 30	2·0	28 50	6·4
21 40	2·1	29 0	6·6
21 50	2·1	29 10	6·7
22 0	2·2	29 20	6·9
22 10	2·2	29 30	7·1
22 20	2·3	29 40	7·2
22 30	2·4	29 50	7·4
22 40	2·5	30 0	7·5
22 50	2·5	30 10	7·6
23 0	2·6	30 20	7·9
23 10	2·7	30 30	8·1
23 20	2·8	30 40	8·2
23 30	2·8	30 50	8·4
23 40	2·9	31 0	8·6

CORRECTION OF THE ALTITUDE OF THE POLE-STAR FOR 1890.

R.A. Mer.	Altitudes 0°	30°	50°	70°	80°	R.A. Mer.	Altitudes 0°	30°	50°	70°	80°	Var. in 10 Years.
h m	*sub.*	*sub.*	*sub.*	*sub.*	*sub.*	h m	*add*	*add*	*add*	*add*	*add*	*sub.*
0 0	1°13′	1°13′	1°13′	1°13′	1°13′	12 0	1°13′	1°13′	1°13′	1°14′	1°14′	3′
0 30	1 15	1 15	1 15	1 15	1 15	12 30	1 15	1 15	1 15	1 15	1 16	3
1 0	1 17	1 17	1 17	1 17	1 17	13 0	1 17	1 17	1 17	1 17	1 17	3
1 30	1 17	1 17	1 17	1 17	1 17	13 30	1 17	1 17	1 17	1 17	1 17	3
2 0	1 16	1 16	1 16	1 16	1 16	14 0	1 16	1 16	1 16	1 16	1 16	3
2 20	1 14	1 14	1 14	1 14	1 13	14 20	1 14	1 14	1 14	1 14	1 14	3
2 40	1 12	1 12	1 12	1 12	1 11	14 40	1 12	1 12	1 12	1 12	1 13	3
3 0	1 9	1 9	1 9	1 9	1 8	15 0	1 9	1 9	1 9	1 10	1 10	2
3 10	1 7	1 7	1 7	1 7	1 6	15 10	1 7	1 8	1 8	1 8	1 9	2
3 20	1 6	1 5	1 5	1 5	1 4	15 20	1 6	1 6	1 6	1 6	1 7	2
3 30	1 5	1 4	1 4	1 4	1 3	15 30	1 5	1 5	1 5	1 5	1 6	2
3 40	1 3	1 3	1 2	1 2	1 1	15 40	1 3	1 3	1 3	1 4	1 5	2
3 50	1 0	1 0	1 0	1 0	0 58	15 50	1 0	1 1	1 1	1 1	1 3	2
4 0	0 58	0 58	0 58	0 57	0 56	16 0	0 58	0 59	0 59	0 59	1 1	2
4 10	0 56	0 56	0 55	0 55	0 53	16 10	0 56	0 56	0 56	0 57	0 59	1
4 20	0 54	0 54	0 54	0 53	0 52	16 20	0 54	0 55	0 55	0 56	0 57	1
4 30	0 52	0 51	0 51	0 50	0 49	16 30	0 52	0 52	0 52	0 53	0 55	1
4 40	0 49	0 49	0 48	0 48	0 46	16 40	0 49	0 49	0 50	0 51	0 52	1
4 50	0 46	0 46	0 45	0 45	0 43	16 50	0 46	0 47	0 47	0 48	0 50	1
5 0	0 44	0 44	0 44	0 43	0 41	17 0	0 44	0 45	0 45	0 46	0 48	1
5 10	0 41	0 41	0 41	0 40	0 37	17 10	0 41	0 42	0 42	0 43	0 45	1
5 20	0 38	0 38	0 38	0 36	0 34	17 20	0 38	0 39	0 39	0 40	0 43	0
5 30	0 35	0 35	0 34	0 33	0 31	17 30	0 35	0 36	0 36	0 37	0 41	0
5 40	0 32	0 32	0 31	0 30	0 28	17 40	0 32	0 33	0 33	0 34	0 37	0
5 50	0 29	0 28	0 28	0 27	0 24	17 50	0 29	0 29	0 30	0 31	0 33	0
6 0	0 26	0 25	0 25	0 23	0 21	18 0	0 26	0 26	0 27	0 28	0 30	0
6 10	0 22	0 22	0 21	0 20	0 17	18 10	0 22	0 23	0 23	0 25	0 27	0
6 20	0 19	0 18	0 18	0 16	0 14	18 20	0 19	0 19	0 20	0 21	0 24	0
6 30	0 16	0 16	0 15	0 14	0 11	18 30	0 16	0 17	0 17	0 19	0 21	0
6 40	0 13	0 12	0 12	0 10	0 8	18 40	0 13	0 13	0 14	0 15	0 18	0
6 50	0 9	0 9	0 8	0 7	0 4	18 50	0 9	0 10	0 11	0 12	0 15	0
7 0	0 6	0 5	0 5	0 3 *add*	0 1 *add*	19 0	0 6	0 6	0 7	0 9	0 11	0
7 10	0 3 *add*	0 3 *add*	0 2 *add*	0 1	0 3	19 10	0 3 *sub.*	0 4 *sub.*	0 5	0 6	0 9	0
7 20	0 1	0 2	0 2	0 4	0 6	19 20	0 1	0 1	0 0 *sub.*	0 1 *sub.*	0 4	1
7 30	0 4	0 4	0 5	0 6	0 9	19 30	0 4	0 3	0 2	0 1	0 2 *sub.*	1
7 40	0 7	0 8	0 8	0 10	0 12	19 40	0 7	0 7	0 6	0 5	0 2	1
7 50	0 11	0 11	0 12	0 13	0 16	19 50	0 11	0 10	0 9	0 8	0 5	2
8 0	0 14	0 15	0 15	0 17	0 19	20 0	0 14	0 14	0 13	0 12	0 9	2
8 10	0 17	0 18	0 18	0 20	0 22	20 10	0 17	0 17	0 16	0 15	0 12	2
8 20	0 21	0 21	0 22	0 23	0 26	20 20	0 21	0 20	0 20	0 18	0 16	2
8 30	0 24	0 25	0 25	0 26	0 29	20 30	0 24	0 24	0 23	0 22	0 20	2
8 40	0 27	0 28	0 28	0 30	0 32	20 40	0 27	0 27	0 27	0 25	0 23	2
8 50	0 30	0 30	0 31	0 32	0 34	20 50	0 30	0 29	0 29	0 28	0 25	2
9 0	0 33	0 33	0 34	0 35	0 37	21 0	0 33	0 32	0 32	0 31	0 29	2
9 10	0 36	0 36	0 37	0 38	0 40	21 10	0 36	0 36	0 35	0 34	0 32	3
9 20	0 39	0 39	0 40	0 41	0 43	21 20	0 39	0 39	0 38	0 37	0 35	3
9 30	0 42	0 42	0 43	0 44	0 45	21 30	0 42	0 42	0 41	0 40	0 38	3
9 40	0 45	0 45	0 46	0 47	0 48	21 40	0 45	0 45	0 44	0 43	0 41	3
9 50	0 47	0 47	0 47	0 48	0 50	21 50	0 47	0 46	0 46	0 45	0 43	3
10 0	0 50	0 51	0 51	0 52	0 53	22 0	0 50	0 50	0 50	0 49	0 47	3
10 10	0 53	0 53	0 53	0 54	0 55	22 10	0 53	0 53	0 52	0 52	0 50	3
10 20	0 55	0 56	0 56	0 57	0 58	22 20	0 55	0 55	0 55	0 54	0 53	3
10 30	0 57	0 57	0 57	0 58	0 59	22 30	0 57	0 56	0 56	0 56	0 55	3
10 40	0 59	0 59	0 59	1 0	1 1	22 40	0 59	0 59	0 59	0 58	0 57	3
10 50	1 1	1 1	1 1	1 2	1 3	22 50	1 1	1 1	1 1	1 0	0 59	3
11 0	1 3	1 3	1 3	1 4	1 5	23 0	1 3	1 3	1 3	1 2	1 1	3
11 20	1 7	1 7	1 7	1 7	1 8	23 20	1 7	1 7	1 6	1 6	1 6	3
11 40	1 10	1 10	1 10	1 10	1 10	23 40	1 10	1 10	1 9	1 9	1 9	3
12 0	1 13	1 13	1 13	1 14	1 14	24 0	1 13	1 13	1 13	1 13	1 13	3

TABLE 52

REDUCTION OF LATITUDE

Compression $\frac{1}{293}$,

(Clarke's figure of the earth)

Lat.	Red.	Lat.	Red.	Lat.	Red.
0°	0′ 0″	30°	10′ 9″	60°	10′ 11″
1	0 24	31	10 21	61	9 58
2	0 49	32	10 32	62	9 45
3	1 13	33	10 42	63	9 31
4	1 38	34	10 52	64	9 16
5	2 2	35	11 1	65	9 1
6	2 26	36	11 9	66	8 44
7	2 50	37	11 16	67	8 27
8	3 13	38	11 23	68	8 10
9	3 37	39	11 28	69	7 52
10	4 0	40	11 33	70	7 34
11	4 23	41	11 37	71	7 15
12	4 45	42	11 40	72	6 55
13	5 8	43	11 42	73	6 35
14	5 30	44	11 44	74	6 14
15	5 51	45	11 44	75	5 53
16	6 12	46	11 44	76	5 32
17	6 33	47	11 43	77	5 10
18	6 53	48	11 40	78	4 47
19	7 12	49	11 38	79	4 25
20	7 31	50	11 34	80	4 2
21	7 50	51	11 29	81	3 38
22	8 8	52	11 24	82	3 15
23	8 25	53	11 17	83	2 51
24	8 42	54	11 10	84	2 27
25	8 58	55	11 2	85	2 3
26	9 14	56	10 54	86	1 38
27	9 28	57	10 44	87	1 14
28	9 43	58	10 34	88	0 49
29	9 56	59	10 23	89	0 25

TABLE 53

CORRECTION OF THE LUNAR DISTANCE FOR THE CONTRACTION OF THE VERTICAL SEMIDIAMETER

Alt.	Angle between the Lun. Dist. and the Plumb Line									
	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
3°	51″	49″	45″	38″	30″	21″	13″	6″	1″	0
4	36	35	32	27	21	15	9	4	1	0
5	26	24	22	19	15	10	6	3	1	0
6	20	19	18	15	12	8	5	2	0	0
7	16	16	14	12	9	6	4	2	0	0
8	11	11	10	9	7	4	3	1	0	0
9	10	9	9	7	6	4	2	1	0	0
10	9	8	7	6	5	3	2	1	0	0
12	5	5	4	4	3	2	1	1	0	0
15	3	3	2	2	2	1	1	0	0	0
20	2	2	2	2	1	1	0	0	0	0
30	1	1	1	1	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0

For the *nearest* Limb, *sub.*; for the *farthest* Limb, *add.*

TABLE 54

ERROR OF OBSERVATION ARISING FROM ERROR OF PARALLELISM

Obser. Angle.	Error of Parallelism of the Telescope							
	10′	20′	30′	40′	50′	1° 0′	1° 10′	1° 20′
10°	0′ 0″	0′ 1″	0′ 1″	0′ 2″	0′ 4″	0′ 6″	0′ 7″	0′ 10″
20	0 0	0 1	0 3	0 5	0 8	0 11	0 15	0 20
30	0 1	0 2	0 4	0 7	0 12	0 17	0 23	0 30
40	0 1	0 3	0 6	0 10	0 16	0 23	0 31	0 40
50	0 1	0 3	0 8	0 13	0 20	0 29	0 40	0 52
60	0 1	0 4	0 9	0 16	0 25	0 36	0 49	1 4
70	0 1	0 5	0 11	0 20	0 31	0 44	1 0	1 18
80	0 2	0 6	0 13	0 23	0 37	0 53	1 12	1 33
90	0 2	0 7	0 16	0 28	0 44	1 3	1 26	1 52
100	0 2	0 8	0 19	0 33	0 52	1 15	1 42	2 13
110	0 3	0 10	0 22	0 40	1 2	1 30	2 2	2 39
120	0 3	0 12	0 27	0 48	1 16	1 49	2 28	3 14

TABLE 55

FOR CORRECTING THE LUNAR DISTANCE FOR THE SPHEROIDAL FIGURE OF THE EARTH

Latitude	Moon's Altitude									
	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
0° or 90	0	0	0	0	0	0	0	0	0	0
3 .. 87	0	20	40	60	80	90	100	110	120	120
5 .. 85	0	30	70	100	130	150	170	190	200	200
8 .. 82	0	50	110	160	200	240	270	300	310	310
10 .. 80	0	70	140	200	260	300	340	360	380	390
13 .. 77	0	90	170	250	320	380	430	470	490	500
16 .. 74	0	110	200	300	391	460	530	570	600	610
19 .. 71	0	120	240	250	450	540	610	660	690	700
22 .. 68	0	140	270	400	500	610	690	740	780	790
26 .. 64	0	160	310	450	580	690	780	850	890	900
31 .. 59	0	180	340	500	550	770	870	950	990	1010
37 53	0	190	370	550	700	840	950	1030	1080	1100
45	0	200	390	690	740	900	990	1070	1120	1140

FOR COMPUTING THE MOON'S *SECOND* CORRECTION OF DISTANCE

☽'s Cor. of Alt. or Dist.	Apparent Distance																	
	13°	14°	15°	16°	17°	18°	20°	23°	26°	30°	34°	38°	44°	50°	60°	70°	80°	90°
									add									
5′	1″	1″	1″	1″	1″	1″	1″	1″	0″	0″	0″	0″	0″	0″	0″	0″	0″	0
8	2	2	2	2	2	2	2	1	1	1	1	1	1	0	0	0	0	0
10	4	3	3	3	3	3	2	2	2	2	1	1	1	1	1	0	0	0
11	5	4	4	4	3	3	3	2	2	2	2	1	1	1	1	0	0	0
12	5	5	5	4	4	4	3	3	3	2	2	2	1	1	1	0	0	0
13	6	6	6	5	5	5	4	3	3	3	2	2	2	1	1	1	0	0
14	7	7	6	6	6	5	5	4	4	3	3	2	2	1	1	1	0	0
15	9	8	7	7	6	6	5	5	4	3	3	3	2	2	1	1	0	0
16	10	9	8	8	7	7	6	5	5	4	3	3	2	2	1	1	0	0
17	11	10	9	9	8	8	7	6	5	4	4	3	3	2	1	1	0	0
18	12	11	11	10	9	9	8	7	6	5	4	4	3	2	2	1	0	0
19	14	13	12	11	10	10	9	7	6	5	5	4	3	3	2	1	1	0
20	15	14	13	12	11	11	10	8	7	6	5	4	4	3	2	1	1	0
21	17	15	14	13	13	12	11	9	8	7	6	5	4	3	2	1	1	0
22	18	17	16	15	14	13	12	10	9	7	6	5	4	4	2	2	1	0
23	20	19	17	16	15	14	13	11	9	8	7	6	5	4	3	2	1	0
24	22	20	19	18	16	15	14	12	10	9	7	6	5	4	3	2	1	0
25	24	22	20	19	18	17	15	13	11	9	8	7	6	5	3	2	1	0
26	26	24	22	21	19	18	16	14	12	10	9	8	6	5	3	2	1	0
27	28	26	24	22	21	20	17	15	13	11	9	8	7	5	4	2	1	0
28	30	27	26	24	22	21	19	16	14	12	10	9	7	6	4	2	1	0
29	32	29	27	26	24	23	20	17	15	13	11	9	8	6	4	3	1	0
30	34	31	29	27	26	24	22	19	16	14	12	10	8	7	5	3	1	0
31	36	34	31	29	27	26	23	20	17	15	12	11	9	7	5	3	1	0
32	39	36	33	31	29	27	25	21	18	15	13	11	9	7	5	3	2	0
33	41	38	35	33	31	29	26	22	19	16	14	12	10	8	5	3	2	0
34	44	40	38	35	33	31	28	24	21	17	15	13	10	8	6	4	2	0
35	46	43	40	37	35	33	29	25	22	19	16	14	11	9	6	4	2	0
36	49	45	42	39	37	35	31	27	23	20	17	14	12	9	7	4	2	0
37	52	48	45	42	39	37	33	28	24	21	18	15	12	10	7	4	2	0
38	55	51	47	44	41	39	35	30	26	22	19	16	13	11	7	5	2	0
39	57	53	50	46	43	41	36	31	27	23	20	17	14	11	8	5	2	0
40	60	56	52	49	46	43	38	33	29	24	21	18	14	12	8	5	2	0
41	63	59	55	51	48	45	40	35	30	25	22	19	15	12	8	5	3	0
42	67	62	57	54	50	47	42	36	32	27	23	20	16	13	9	6	3	0
43	70	65	60	56	53	50	44	38	33	28	24	21	17	14	9	6	3	0
44	73	68	63	59	55	52	46	40	35	29	25	22	17	14	10	6	3	0
45	76	71	66	62	58	54	49	42	36	31	26	23	18	15	10	6	3	0
46	80	74	69	64	60	57	51	43	38	32	27	24	19	15	11	7	3	0
47	83	77	72	67	63	59	53	45	40	33	29	25	20	16	11	7	3	0
48	87	81	75	70	66	62	55	47	41	35	30	26	21	17	12	7	4	0
49	91	84	78	73	68	64	58	49	43	36	31	27	22	18	12	8	4	0
50	94	87	81	76	71	67	60	51	45	38	32	28	23	18	13	8	4	0
51	98	91	85	79	74	70	62	53	47	39	34	29	24	19	13	8	4	0
52	102	95	88	82	77	73	65	56	48	41	35	30	24	20	14	9	4	0
53	106	98	91	85	80	75	67	58	50	42	36	31	25	21	14	9	4	0
54	110	102	95	89	83	78	70	60	52	44	38	33	26	21	15	9	4	0
55	114	106	98	92	86	81	72	62	54	46	39	34	27	22	15	10	5	0
56	118	110	102	95	89	84	75	64	56	47	41	35	28	23	16	10	5	0
57	123	114	106	99	93	87	78	67	58	49	42	36	29	24	16	10	5	0
58	127	118	109	102	96	90	81	69	60	51	44	38	30	25	17	11	5	0
59	131	122	113	106	99	93	83	72	62	53	45	39	31	25	18	11	5	0
60	136	126	117	109	103	97	86	74	64	54	47	40	33	26	18	11	6	0
														sub.	*sub.*	*sub.*	*sub.*	*sub*
														130°	120°	110°	100°	90°

CORRECTION OF THE GREENWICH MEAN TIME
FOR THE 2D DIFFERENCE OF THE LUNAR DISTANCE

Diff. of Prop. Logs. in the Naut. Alm.	Interval 0h						Interval 1h				Diff. of Prop. Logs. in the Naut. Alm.	Interval 0h						Interval 1h			
	0m	10m	20m	30m	40m	50m	0m	10m	20m	30m		0m	10m	20m	30m	40m	50m	0m	10m	20m	30m
6	0s	0s	1s	1s	1s	1s	2s	2s	2s	2s	114	0s	8s	14s	20s	24s	28s	31s	34s	35s	35
12	0	1	1	2	3	3	3	4	4	4	120	0	8	15	21	26	30	32	36	37	37
18	0	1	2	3	4	4	5	5	6	6	126	0	9	16	22	27	31	34	37	39	39
24	0	2	3	4	5	6	6	7	7	7	132	0	9	17	23	28	33	36	39	40	41
30	0	2	3	5	6	7	8	9	9	9	138	0	9	18	24	30	34	37	41	42	43
36	0	2	4	6	8	9	10	11	11	11	144	0	10	18	25	31	36	39	43	44	45
42	0	3	5	7	9	10	11	12	13	14	150	0	10	19	26	32	37	40	44	47	47
48	0	3	6	8	10	12	13	14	15	15	156	0	11	20	27	33	39	42	46	48	48
54	0	4	7	9	12	13	15	16	17	17	162	0	11	21	28	35	40	44	48	50	50
60	0	4	7	10	13	15	16	18	18	19	168	0	11	21	29	36	42	45	50	52	52
66	0	4	8	11	14	16	18	19	20	20	174	0	12	22	30	37	43	47	51	53	54
72	0	5	9	12	15	18	19	21	22	22	180	0	12	23	31	39	45	49	53	55	56
78	0	5	10	13	17	19	21	23	24	24	186	0	12	24	32	40	46	50	55	57	58
84	0	6	10	14	18	21	23	25	26	26	192	0	13	24	33	41	48	52	57	59	60
90	0	6	11	15	19	22	24	27	28	28	198	0	13	25	34	43	49	53	58	61	62
96	0	7	12	17	21	25	26	28	29	30	204	0	14	26	35	44	51	55	60	63	63
102	0	7	12	18	22	25	27	30	31	32	210	0	14	26	36	45	52	57	62	64	65
108	0	7	13	19	23	27	29	32	33	33	216	0	14	27	37	46	54	58	64	66	67
	0m	50m	40m	30m	20m	10m	0m	50m	40m	30m		0m	50m	40m	30m	20m	10m	0m	50m	40m	30m
	3h	Interval 2h						Interval 1h				3h	Interval 2h						Interval 1h		

TABLE 58

ERROR OF THE SHIP'S PLACE IN NAUTICAL MILES, AND OF THE LONG. IN TIME,

Corresponding to an Error of 1′ in the Lunar Distance.

Prop. Log. in the Naut. Alm.	Change in 3 hours	Latitude 0°	10°	20°	30°	40°	50°	60°	70°	80°	Error of Long. in Time.
		mil.	mil.	mil.	mil.	mil.	mil.	mil.	mil.	mil.	m s
2218	1°48′	25	25	23	22	19	16	12	9	4	1 40
2341	1 45	26	26	24	22	20	17	13	9	4	1 44
2467	1 42	27	27	25	23	21	17	13	9	5	1 48
2596	1 39	28	27	26	24	21	18	14	10	5	1 52
2685	1 37	29	28	27	25	22	19	14	10	5	1 56
2821	1 34	30	29	28	26	23	19	15	10	5	2 0
2962	1 31	31	30	29	27	24	20	15	11	5	2 4
3103	1 28	32	31	30	28	24	21	16	11	5	2 8
3259	1 25	33	32	31	28	25	21	16	11	6	2 12
3415	1 22	34	33	32	29	26	22	17	12	6	2 16
3522	1 20	35	34	33	30	27	22	17	12	6	2 20
3688	1 17	36	35	34	31	28	23	18	12	6	2 24
3860	1 14	37	36	35	32	28	24	18	13	6	2 28
4040	1 11	38	37	36	33	29	24	19	13	7	2 32

AMPLITUDES

Lat.	Declination															
	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°
°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
0	0	1·0	2·0	3·0	4·0	5·0	6·0	7·0	8·0	9·0	10·0	11·0	12·0	13·0	14·0	15·0
10	0	1·0	2·0	3·0	4·1	5·1	6·1	7·0	8·1	9·1	10·1	11·2	12·2	13·2	14·2	15·2
15	0	1·0	2·1	3·1	4·2	5·2	6·2	7·2	8·3	9·3	10·4	11·4	12·5	13·5	14·5	15·6
20	0	1·1	2·1	3·2	4·3	5·3	6·4	7·5	8·5	9·6	10·6	11·7	12·8	13·8	14·9	16·0
25	0	1·1	2·2	3·3	4·4	5·5	6·6	7·7	8·8	9·9	11·1	12·4	13·3	14·4	15·5	16·6
30	0	1·2	2·3	3·4	4·6	5·8	6 9	8·1	9·3	10·3	11·6	12·7	13·9	15·0	16·2	17·4
32	0	1·2	2·4	3·5	4·7	5·9	7·1	8·3	9·5	10·6	11·8	13·0	14·2	15·4	16·6	17·8
34	0	1·2	2·4	3·6	4·8	6·0	7·2	8·4	9·7	10·8	12·1	13·3	14·5	15·7	17·0	18·2
35	0	1·2	2·4	3·7	4·9	6·1	7·3	8·5	9·8	11·0	12·2	13·5	14·7	15·9	17·2	18·4
36	0	1·2	2·5	3·7	4·9	6·2	7·4	8·7	9·9	11·1	12·4	13·6	14·9	16·1	17·4	18·7
37	0	1·2	2·5	3·7	5·0	6·3	7·5	8·8	10·0	11·3	12·6	13·8	15·1	16·4	17·6	18·9
38	0	1·3	2·5	3·8	5·1	6·3	7·6	8·9	10·2	11·4	12·7	14·0	15·3	16·6	17·9	19·2
39	0	1·3	2·6	3·8	5·1	6·4	7·7	9·0	10·3	11·6	12·9	14·2	15·5	16·8	18·1	19·4
40	0	1·3	2·6	3·9	5·2	6·5	7·8	9·1	10·5	11·8	13·1	14·4	15·7	17·1	18·4	19·7
41	0	1·3	2·6	4·0	5·3	6·6	8·0	9·3	10·6	12·0	13·3	14·6	16·0	17·3	18·7	20·0
42	0	1·3	2·7	4·0	5·4	6·7	8·1	9·4	10·8	12·1	13·5	14·8	16·2	17·6	19·0	20·4
43	0	1·4	2·7	4·1	5·5	6·8	8·2	9·6	11·0	12·3	13·7	15·1	16·5	17·9	19·3	20·7
44	0	1·4	2·8	4·2	5·6	7·0	8·3	9·7	11·1	12·6	14·0	15·4	16·8	18·2	19·6	21·1
45	0	1·4	2·8	4·2	5·7	7·1	8·5	9·9	11·3	12·8	14·2	15·6	17·1	18·5	20·0	21·5
46	0	1·4	2·9	4·3	5·8	7·2	8·6	10·1	11·5	13·0	14·5	15·9	17·4	18·9	20·4	21·9
47	0	1·4	2·9	4·4	5·8	7·3	8·8	10·3	11·8	13·3	14·7	16·2	17·7	19·3	20·8	22·3
48	0	1·5	3·0	4·5	6·0	7·5	9·0	10·5	12·0	13·5	15·0	16·6	18·1	19·5	21·2	22·7
49	0	1·5	3·0	4·6	6·1	7·6	9·2	10·7	12·2	13·8	15·3	16·9	18·5	20·0	21·6	23·2
50	0	1·5	3·1	4·7	6·2	7·8	9·3	10·9	12·5	14·1	15·7	17·3	18·9	20·5	22·1	23·7
51	0	1·6	3·2	4·8	6·4	8·0	9·6	11·2	12·8	14·4	16·0	17·6	19·3	20·9	22·6	24·3
52	0	1·6	3·3	4·9	6·5	8·1	9·7	11·4	13·1	14·7	16·4	18·0	19·7	21·4	23·1	24·9
53	0	1·6	3·3	5·0	6·7	8·3	10·0	11·7	13·4	15·1	16·8	18·5	20·2	21·9	23·7	25·5
54	0	1·7	3·4	5·1	6·8	8·5	10·2	12·0	13·7	15·4	17·2	18·9	20·7	22·5	24·3	26·1
55	0	1·7	3·5	5·2	7·0	8·7	10·5	12·3	14·0	15·8	17·6	19·4	21·2	23·1	24·9	26·8
56	0	1·8	3·6	5·4	7·2	9·0	10·7	12·6	14·4	16·2	18·1	19·9	21·8	23·7	25·6	27·6
57	0	1·8	3·7	5·5	7·4	9·2	11·1	12·9	14·8	16·7	18·3	20·5	22·4	24·4	26·4	28·4
58	0	1·9	3·8	5·7	7·6	9·5	11·4	13·3	15·2	17·2	19·1	21·1	23·1	25·1	27·2	29·2
59	0	1·9	3·8	5·8	7·8	9·7	11·7	13·7	15·7	17·7	19·7	21·7	23·8	25·9	28·0	30·2
60	0	2·0	4·0	6·0	8·0	10·0	12·1	14·1	16·2	18·2	20·3	22·4	24·6	26·7	28·9	31·2
61	0	2·1	4·1	6·2	8·3	10·3	12·5	14·6	16·7	18·8	21·0	23·1	25·4	27·6	29·9	32·2
62	0	2·1	4·3	6·4	8·5	10·7	12·9	15·1	17·3	19·4	21·9	23·9	26·3	28·5	31·0	33·4
63	0	2·2	4·5	6·7	8·8	11·1	13·4	15·6	17·9	20·1	22·5	24·8	27·3	29·6	32·2	34·7
64	0	2·3	4·6	6·9	9·1	11·5	13·9	16·2	18·5	20·9	23·3	25·7	28·3	30·9	33·5	36·2
65	0	2·4	4·8	7·1	9 5	11·9	14·4	16·8	19·3	21·7	24·2	26·8	29·5	32·5	34·9	37·8

TABLE 59 A

CORRECTION OF THE AMPLITUDE OBSERVED ON THE HORIZON,

FOR THE EFFECT OF REFRACTION.

(Height of the Eye, 16 feet.)

Lat.	Declination							
	0°	10°	15°	18°	20°	22°	23°	24°
0	0°	0°	0°	0°	0°	0°	0°	0°
10	0	0·1	0·1	0·1	0·1	0·1	0·1	0·1
20	0·2	0·2	0·2	0·3	0·3	0·3	0·3	0·3
30	0·3	0·3	0·3	0·3	0·4	0·4	0·5	0·5
40	0·5	0·5	0·7	0·7	0·7	0·8	0·8	0·8
50	0·7	0·8	0·9	0·9	0·9	0·9	1·0	1·0
55	0·9	0·9	1·1	1·2	1·3	1·3	1·4	1·4
60	1·1	1·1	1·3	1·4	1·5	1·7	1·8	1·9
65	1·3	1·4	1·9	2·3	2·5			

AMPLITUDES

Lat.	Declination 16°	16½°	17°	17½°	18°	18½°	19°	19½°	20°	20½°	21°	21½°	22°	22½°	23°	23½°
°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
0	16·0	16·5	17·0	17·5	18·0	18·5	19·0	19·5	20·0	20·5	21·0	21·5	22·0	22·5	23·0	23·5
10	16·2	16·7	17·3	17·8	18·3	18·8	19·3	19·9	20·3	20·8	21·3	21·8	22·3	22·9	23·4	23·9
15	16·6	17·1	17·7	18·1	18·7	19·2	19·7	20·2	20·8	21·3	21·8	22·3	22·8	23·3	23·9	24·3
20	17·1	17·6	18·1	18·7	19·2	19·7	20·3	20·8	21·3	21·9	22·4	22·9	23·5	24·0	24·6	25·1
25	17·7	18·3	18·8	19·4	19·9	20·5	21·0	21·6	22·5	22·7	23·3	23·8	24·4	24·6	25·5	26·1
30	18·6	19·1	19·7	20·3	20·9	21·5	22·1	22·7	23·3	23·8	24·4	25·0	25·6	26·2	26·8	27·4
32	19·0	19·6	20·2	20·8	21·4	22·0	22·6	23·2	23·8	24·4	25·0	25·6	26·2	26·8	27·4	28·0
34	19·4	20·0	20·6	21·3	21·9	22·5	23·1	23·7	24·4	25·0	25·6	26·2	26·8	27·5	28·1	28·7
35	19·6	20·3	20·9	21·5	22·2	22·8	23·4	24·0	24·7	25·3	25·9	26·6	27·2	27·8	28·5	29·1
36	19·9	20·5	21·2	21·8	22·4	23·1	23·7	24·4	25·0	25·6	26·3	26·9	27·6	28·2	28·9	29·5
37	20·2	20·8	21·5	22·1	22·8	23·4	24·0	24·7	25·3	26·0	26·7	27·3	28·0	28·6	29·3	29·9
38	20·5	21·1	21·8	22·4	23·1	23·7	24·4	25·1	25·7	26·4	27·0	27·7	28·4	29·0	29·7	30·3
39	20·8	21·4	22·1	22·8	23·4	24·1	24·8	25·4	26·1	26·8	27·5	28·1	28·8	29·5	30·2	30·8
40	21·1	21·8	22·4	23·1	23·8	24·5	25·1	25·8	26·5	27·2	27·9	28·6	29·3	30·0	30·7	31·3
41	21·4	22·1	22·8	23·5	24·2	24·8	25·5	26·2	26·9	27·6	28·3	29·0	29·8	30·5	31·2	31·8
42	21·8	22·5	23·2	23·8	24·6	25·3	26·0	26·7	27·4	28·1	28·8	29·5	30·3	31·0	31·7	32·4
43	22·1	22·8	23·6	24·3	25·0	25·7	26·4	27·1	27·8	28·6	29·3	30·1	30·8	31·5	32·3	33·0
44	22·5	23·2	24·0	24·7	25·6	26·2	26·9	27·6	28·4	29·1	29·8	30·6	31·4	32·1	32·9	33·6
45	22·9	23·7	24·4	25·2	25·9	26·7	27·4	28·2	28·9	29·7	30·4	31·2	32·0	32·8	33·5	34·3
46	23·4	24·1	24·8	25·6	26·4	27·2	27·9	28·7	29·5	30·3	31·0	31·8	32·6	33·4	34·2	35·0
47	23·8	24·6	25·4	26·2	26·9	27·7	28·5	29·3	30·1	30·9	31·7	32·5	33·3	34·1	34·9	35·7
48	24·3	25·1	25·9	26·7	27·5	28·3	29·1	29·9	30·7	31·6	32·4	33·2	34·0	34·8	35·7	36·5
49	24·8	25·6	26·5	27·3	28·1	28·9	29·7	30·6	31·4	32·3	33·1	33·9	34·8	35·7	36·5	37·4
50	25·4	26·2	27·0	27·8	28·7	29·6	30·4	31·3	32·1	33·0	33·9	34·8	35·6	36·5	37·4	38·3
51	26·0	26·8	27·7	28·5	29·4	30·3	31·1	32·0	32·9	33·8	34·7	35·6	36·5	37·5	38·4	39·3
52	26·6	27·5	28·3	29·2	30·1	31·0	31·9	32·8	33·7	34·7	35·6	36·5	37·5	38·4	39·4	40·3
53	27·3	28·2	29·1	30·0	30·9	31·8	32·7	33·7	34·6	35·6	36·5	37·5	38·5	39·5	40·5	41·4
54	28·0	28·9	29·8	30·8	31·7	32·7	33·6	34·6	35·6	36·6	37·6	38·6	39·6	40·6	41·7	42·6
55	28·7	29·7	30·6	31·6	32·6	33·6	34·6	35·6	36·6	37·6	38·7	39·7	40·8	41·8	42·9	44·0
56	29·5	30·5	31·5	32·5	33·5	34·6	35·6	36·6	37·7	38·8	39·8	40·9	42·1	43·2	44·3	45·4
57	30·4	31·4	32·5	33·5	34·5	35·6	36·7	37·8	38·9	40·0	41·1	42·3	43·4	44·6	45·8	47·0
58	31·3	32·4	33·5	34·6	35·7	36·8	37·9	39·0	40·2	41·7	42·5	43·8	45·0	46·2	47·5	48·7
59	32·3	33·5	34·6	35·7	36·8	38·0	39·2	40·4	41·6	42·8	44·1	45·4	46·7	48·0	49·3	50·6
60	33·4	34·6	35·8	37·0	38·2	39·4	40·6	41·9	43·2	44·5	45·8	47·1	48·5	49·9	51·4	52·8
61	34·6	35·8	37·1	38·3	39·6	40·8	42·2	43·5	44·8	46·2	47·7	49·1	50·6	52·1	53·7	55·2
62	35·9	37·2	38·5	39·8	41·2	42·5	43·9	45·3	46·8	48·2	49·8	51·3	52·9	54·6	56·3	58·0
63	37·4	38·7	40·1	41·5	42·9	44·3	45·8	47·3	48·8	50·5	52·1	53·8	55·6	57·4	59·4	61·3
64	39·0	40·4	41·8	43·3	44·8	46·4	48·0	49·6	51·3	53·0	54·8	56·7	58·7	60·8	63·0	65·3
65	40·7	42·2	43·8	45·4	47·0	48·7	50·4	52·2	54·0	56·0	58·0	60·1	62·4	64·9	67·6	70·4

TABLE 59 A

CORRECTION OF THE AMPLITUDE OBSERVED ON THE HORIZON,

FOR THE EFFECT OF REFRACTION.

(Height of the Eye, 16 feet.)

Lat.	Declination 0°	10°	15°	18°	20°	22°	23°	24°
0	0°	0°	0°	0°	0°	0°	0°	0°
10	0·1	0·1	0·1	0·1	0·1	0·1	0·1	0·1
20	0·2	0·2	0·2	0·3	0·3	0·3	0·3	0·3
30	0·3	0·3	0·3	0·3	0·4	0·4	0·5	0·5
40	0·5	0·5	0·7	0·7	0·7	0·8	0·8	0·8
50	0·7	0·8	0·9	0·9	0·9	0·9	1·0	1·0
55	0·9	0·9	1·1	1·2	1·3	1·3	1·4	1·4
60	1·1	1·1	1·3	1·4	1·5	1·7	1·9	1·9
65	1·3	1·4	1·9	2·3	2·5			

DECLINATION OF THE SUN, FOR THE YEAR 1901,
At Apparent Noon at Greenwich.

Day	Jan.	Feb.	Mar.	April	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1	23 2S	17 12S	7 44S	4 23N	14 57N	22 0N	23 9N	18 9N	8 27N	3 1S	14 18S	21 45S
2	22 57	16 55	7 21	4 46	15 15	22 8	23 5	17 54	8 5	3 24	14 37	21 54
3	22 52	16 38	6 58	5 9	15 33	22 16	23 1	17 38	7 43	3 47	14 56	22 3
4	22 46	16 20	6 35	5 32	15 51	22 23	22 56	17 22	7 21	4 11	15 15	22 12
5	22 40	16 2	6 12	5 55	16 8	22 30	22 50	17 6	6 59	4 34	15 33	22 20
6	22 33	15 44	5 49	6 18	16 25	22 37	22 45	16 50	6 37	4 57	15 52	22 27
7	22 26	15 25	5 26	6 40	16 42	22 43	22 39	16 34	6 15	5 20	16 10	22 34
8	22 18	15 7	5 2	7 3	16 58	22 49	22 32	16 17	5 52	5 43	16 27	22 41
9	22 10	14 48	4 39	7 25	17 15	22 54	22 26	16 0	5 29	6 6	16 45	22 47
10	22 1	14 28	4 15	7 48	17 31	22 59	22 18	15 42	5 7	6 29	17 2	22 53
11	21 52	14 9	3 52	8 10	17 46	23 4	22 11	15 25	4 44	6 51	17 19	22 59
12	21 43	13 49	3 29	8 32	18 2	23 8	22 3	15 7	4 21	7 14	17 35	23 3
13	21 33	13 29	3 5	8 54	18 17	23 12	21 54	14 49	3 58	7 37	17 52	23 8
14	21 23	13 9	2 41	9 15	18 31	23 15	21 46	14 31	3 35	7 59	18 8	23 12
15	21 12	12 48	2 18	9 37	18 46	23 18	21 37	14 12	3 12	8 21	18 23	23 15
16	21 1	12 28	1 54	9 58	19 0	23 20	21 27	13 53	2 49	8 44	18 38	23 18
17	20 49	12 7	1 30	10 20	19 14	23 23	21 17	13 34	2 26	9 6	18 53	23 21
18	20 37	11 46	1 6	10 41	19 27	23 24	21 7	13 15	2 3	9 28	19 8	23 23
19	20 25	11 25	0 43	11 2	19 41	23 26	20 56	12 56	1 39	9 50	19 23	23 25
20	20 12	11 3	0 19S	11 22	19 53	23 26	20 46	12 36	1 16	10 11	19 36	23 26
21	19 59	10 42	0 5N	11 43	20 6	23 27	20 34	12 16	0 53	10 33	19 50	23 27
22	19 46	10 20	0 28	12 3	20 18	23 27	20 23	11 57	0 29	10 54	20 3	23 27
23	19 32	9 58	0 52	12 23	20 30	23 27	20 11	11 36	0 6N	11 15	20 16	23 27
24	19 18	9 36	1 16	12 43	20 41	23 26	19 58	11 16	0 17S	11 36	20 28	23 26
25	19 3	9 14	1 39	13 3	20 52	23 25	19 46	10 55	0 41	11 57	20 41	23 25
26	18 49	8 52	2 3	13 23	21 3	23 23	19 33	10 35	1 4	12 18	20 52	23 23
27	18 33	8 29	2 26	13 42	21 14	23 21	19 20	10 14	1 27	12 39	21 4	23 21
28	18 18	8 7	2 50	14 1	21 24	23 19	19 6	9 53	1 51	12 59	21 15	23 19
29	18 2		3 13	14 20	21 33	23 16	18 52	9 32	2 14	13 19	21 25	23 16
30	17 46		3 37	14 39	21 43	23 13	18 38	9 10	2 38	13 39	21 35	23 12
31	17 29		4 0		21 51		18 23	8 49		13 59		23 8

DECLINATION OF THE SUN, FOR 1902.

Day	Jan.	Feb.	Mar.	April	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1	23 4S	17 17S	7 50S	4 17N	14 52N	21 58N	23 10N	18 12N	8 32N	2 55S	14 13S	21 43S
2	22 59	17 0	7 27	4 40	15 11	22 6	23 6	17 57	8 10	3 19	14 33	21 52
3	22 53	16 42	7 4	5 4	15 29	22 14	23 2	17 42	7 49	3 42	14 52	22 1
4	22 48	16 25	6 41	5 27	15 46	22 21	22 57	17 26	7 27	4 5	15 10	22 10
5	22 41	16 7	6 18	5 49	16 4	22 28	22 52	17 10	7 4	4 28	15 29	22 18
6	22 35	15 48	5 55	6 12	16 21	22 35	22 46	16 54	6 42	4 52	15 47	22 25
7	22 27	15 30	5 31	6 35	16 38	22 41	22 40	16 38	6 20	5 15	16 5	22 33
8	22 20	15 11	5 8	6 57	16 54	22 47	22 34	16 21	5 57	5 38	16 23	22 39
9	22 12	14 52	4 45	7 20	17 11	22 53	22 27	16 4	5 35	6 0	16 41	22 46
10	22 3	14 33	4 21	7 42	17 27	22 58	22 20	15 47	5 12	6 23	16 58	22 52
11	21 54	14 14	3 58	8 4	17 42	23 3	22 12	15 29	4 49	6 46	17 15	22 57
12	21 45	13 54	3 34	8 26	17 58	23 7	22 5	15 11	4 27	7 9	17 31	23 2
13	21 35	13 34	3 11	8 48	18 13	23 11	21 56	14 53	4 4	7 31	17 48	23 7
14	21 25	13 14	2 47	9 10	18 28	23 14	21 48	14 35	3 41	7 54	18 4	23 11
15	21 14	12 53	2 23	9 32	18 42	23 17	21 39	14 17	3 18	8 16	18 19	23 15
16	21 3	12 33	2 0	9 53	18 57	23 20	21 29	13 58	2 55	8 38	18 35	23 18
17	20 52	12 12	1 36	10 15	19 11	23 22	21 20	13 39	2 31	9 0	18 50	23 20
18	20 40	11 51	1 12	10 36	19 24	23 24	21 9	13 20	2 8	9 22	19 5	23 23
19	20 28	11 30	0 49	10 57	19 37	23 25	20 59	13 1	1 45	9 44	19 19	23 24
20	20 15	11 9	0 25	11 17	19 50	23 26	20 48	12 41	1 22	10 6	19 33	23 26
21	20 3	10 47	0 1S	11 38	20 3	23 27	20 37	12 21	0 58	10 28	19 47	23 27
22	19 49	10 25	0 23N	11 58	20 15	23 27	20 25	12 1	0 35	10 49	20 0	23 27
23	19 35	10 4	0 46	12 19	20 27	23 27	20 14	11 41	0 12N	11 10	20 13	23 27
24	19 21	9 42	1 10	12 39	20 39	23 26	20 1	11 21	0 12S	11 31	20 25	23 26
25	19 7	9 19	1 33	12 58	20 50	23 25	19 49	11 0	0 35	11 52	20 38	23 25
26	18 52	8 57	1 57	13 18	21 1	23 23	19 36	10 40	0 58	12 13	20 49	23 24
27	18 37	8 35	2 21	13 37	21 11	23 22	19 23	10 19	1 22	12 34	21 1	23 22
28	18 22	8 12	2 44	13 56	21 21	23 19	19 9	9 58	1 45	12 54	21 12	23 19
29	18 6		3 7	14 15	21 31	23 17	18 55	9 37	2 9	13 14	21 23	23 16
30	17 50		3 31	14 34	21 40	23 13	18 41	9 15	2 32	13 34	21 33	23 13
31	17 33		3 54		21 49		18 27	8 54		13 54		23 9

DECLINATION OF THE SUN, FOR THE YEAR 1903.

At Apparent Noon at Greenwich.

Day	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1	23 5S.	17 21S.	7 55S.	4 12N.	14 48N.	21 56N.	23 11N.	18 16N.	8 37N.	2 50S.	14 9S.	21 40S.
2	23 0	17 4	7 33	4 35	15 6	22 4	23 7	18 1	8 16	3 13	14 28	21 50
3	22 55	16 47	7 10	4 58	15 24	22 12	23 3	17 46	7 54	3 36	14 47	21 59
4	22 49	16 29	6 47	5 21	15 42	22 20	22 58	17 30	7 32	4 0	15 6	22 8
5	22 43	16 11	6 24	5 44	16 0	22 27	22 53	17 14	7 10	4 23	15 25	22 16
6	22 36	15 53	6 0	6 7	16 17	22 34	22 48	16 58	6 48	4 46	15 43	22 24
7	22 29	15 35	5 37	6 29	16 34	22 40	22 42	16 42	6 25	5 9	16 1	22 31
8	22 22	15 16	5 14	6 52	16 50	22 46	22 35	16 25	6 3	5 32	16 19	22 38
9	22 14	14 57	4 51	7 14	17 7	22 52	22 29	16 8	5 40	5 55	16 37	22 44
10	22 6	14 38	4 27	7 37	17 23	22 57	22 22	15 51	5 18	6 18	16 54	22 50
11	21 57	14 19	4 4	7 59	17 39	23 2	22 14	15 33	4 55	6 41	17 11	22 56
12	21 47	13 59	3 40	8 21	17 54	23 6	22 6	15 16	4 32	7 3	17 27	23 1
13	21 38	13 39	3 17	8 43	18 9	23 10	21 58	14 58	4 9	7 26	17 44	23 6
14	21 28	13 19	2 53	9 5	18 24	23 13	21 50	14 40	3 46	7 48	18 0	23 10
15	21 17	12 59	2 29	9 26	18 39	23 16	21 41	14 21	3 23	8 11	18 16	23 14
16	21 6	12 38	2 6	9 48	18 53	23 19	21 32	14 3	3 0	8 33	18 31	23 17
17	20 55	12 17	1 42	10 9	19 7	23 21	21 22	13 44	2 37	8 55	18 46	23 20
18	20 43	11 56	1 18	10 30	19 21	23 23	21 12	13 25	2 14	9 17	19 1	23 22
19	20 31	11 35	0 55	10 51	19 34	23 25	21 2	13 5	1 51	9 39	19 16	23 24
20	20 19	11 14	0 31	11 12	19 47	23 26	20 51	12 46	1 27	10 1	19 30	23 26
21	20 6	10 53	0 7S.	11 33	20 0	23 27	20 40	12 26	1 4	10 23	19 43	23 26
22	19 53	10 31	0 17N.	11 53	20 12	23 27	20 28	12 6	0 41	10 44	19 57	23 27
23	19 39	10 9	0 40	12 14	20 24	23 27	20 16	11 46	0 17N.	11 5	20 10	23 27
24	19 25	9 47	1 4	12 34	20 36	23 26	20 4	11 26	0 6S.	11 26	20 23	23 26
25	19 11	9 25	1 28	12 54	20 47	23 25	19 52	11 5	0 30	11 47	20 35	23 25
26	18 56	9 3	1 51	13 13	20 58	23 24	19 39	10 45	0 53	12 8	20 47	23 24
27	18 41	8 40	2 15	13 33	21 9	23 22	19 26	10 24	1 16	12 29	20 58	23 22
28	18 26	8 18S.	2 38	13 52	21 19	23 20	19 13	10 3	1 40	12 49	21 9	23 20
29	18 10		3 2	14 11	21 29	23 17	18 59	9 42	2 3	13 9	21 20	23 17
30	17 54		3 25	14 30	21 38	23 14N.	18 45	9 20	2 26S.	13 29	21 30S.	23 14
31	17 38S.		3 48N.	N.	21 47N.		18 30N.	8 59N.		13 49S.		23 10S.

DECLINATION OF THE SUN, FOR 1904.

Day	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1	23 6S.	17 25S.	7 38S.	4 29N.	15 2N.	22 2N.	23 8N.	18 5N.	8 21N.	3 7S.	14 23S.	21 48S.
2	23 1	17 8	7 15	4 52	15 20	22 10	23 4	17 49	7 59	3 31	14 42	21 57
3	22 56	16 51	6 52	5 15	15 38	22 18	22 59	17 34	7 37	3 54	15 1	22 5
4	22 50	16 33	6 29	5 38	15 55	22 25	22 54	17 18	7 15	4 17	15 20	22 14
5	22 44	16 16	6 6	6 1	16 13	22 32	22 49	17 2	6 53	4 40	15 39	22 22
6	22 38	15 58	5 43	6 24	16 30	22 38	22 43	16 46	6 31	5 3	15 57	22 29
7	22 31	15 39	5 20	6 46	16 40	22 44	22 37	16 29	6 8	5 26	16 15	22 36
8	22 24	15 21	4 56	7 9	17 3	22 50	22 30	16 12	5 46	5 49	16 32	22 43
9	22 16	15 2	4 33	7 31	17 19	22 55	22 23	15 55	5 23	6 12	16 50	22 49
10	22 8	14 43	4 9	7 54	17 35	23 0	22 16	15 38	5 1	6 35	17 7	22 55
11	21 59	14 23	3 46	8 16	17 50	23 5	22 8	15 20	4 38	6 58	17 23	23 0
12	21 50	14 4	3 22	8 38	18 6	23 9	22 0	15 2	4 15	7 20	17 40	23 5
13	21 40	13 44	2 59	9 0	18 21	23 12	21 51	14 44	3 52	7 43	17 56	23 9
14	21 30	13 24	2 35	9 21	18 35	23 16	21 43	14 26	3 29	8 5	18 12	23 13
15	21 20	13 4	2 11	9 43	18 50	23 19	21 34	14 7	3 6	8 28	18 27	23 16
16	21 9	12 43	1 48	10 4	19 1	23 21	21 24	13 48	2 43	8 50	18 43	23 19
17	20 58	12 22	1 24	10 25	19 18	23 23	21 14	13 29	2 20	9 12	18 58	23 22
18	20 46	12 1	1 0	10 46	19 31	23 25	21 4	13 10	1 56	9 34	19 12	23 24
19	20 34	11 40	0 37	11 7	19 44	23 26	20 53	12 51	1 33	9 56	19 26	23 25
20	20 22	11 19	0 13S.	11 28	19 57	23 27	20 42	12 31	1 10	10 17	19 40	23 26
21	20 9	10 58	0 11N.	11 48	20 9	23 27	20 31	12 11	0 46	10 39	19 54	23 27
22	19 56	10 36	0 35	12 9	20 21	23 27	20 19	11 51	0 23N.	11 0	20 7	23 27
23	19 42	10 14	0 58	12 29	20 33	23 26	20 7	11 31	0 0	11 21	20 19	23 27
24	19 28	9 52	1 22	12 49	20 44	23 25	19 55	11 10	0 24S.	11 42	20 32	23 26
25	19 14	9 30	1 45	13 8	20 55	23 24	19 42	10 50	0 47	12 3	20 44	23 25
26	19 0	9 8	2 9	13 28	21 6	23 22	19 29	10 29	1 10	12 24	20 55	23 23
27	18 45	8 46	2 33	13 47	21 16	23 20	19 16	10 8	1 34	12 44	21 6	23 20
28	18 29	8 23	2 56	14 6	21 26	23 18	19 2	9 47	1 57	13 4	21 17	23 18
29	18 14	8 0S.	3 19	14 25	21 36	23 15	18 18	9 26	2 21	13 24	21 28	23 15
30	17 58		3 43	14 44N.	21 45	23 12N.	18 34	9 4	2 44S.	13 44	21 38S.	23 11
31	17 42S.		4 6N.		21 54N.		18 19N.	8 43N.		14 4S.		23 7S.

CORRECTION OF THE SUN'S DECLINATION, IN TABLE 60,

FOR THE YEARS FOLLOWING 1901, 1902, 1903, 1904.

Given Years.	Following Years.						Given Years.	Following Years.					
1901 1902 1903 1904	1905 1906 1907 1908	1909 1910 1911 1912	1913 1914 1915 1916	1917 1918 1919 1920	1921 1922 1923 1924	1925 1926 1927 1928	1901 1902 1903 1904	1905 1906 1907 1908	1909 1910 1911 1912	1913 1914 1915 1916	1917 1918 1919 1920	1921 1922 1923 1924	1925 1926 1927 1928
	sub.	*sub.*	*sub*	*sub.*	*sub.*	*sub.*		*sub.*	*sub.*	*sub.*	*sub.*	*sub.*	*sub*
Jan. 1	0'·1	0'·3	0'·4	0'·6	0'·7	0'·9	June 30	0'·1	0'·3	0'·4	0'·6	0'·7	0'·8
10	0·2	0·5	0·8	1·0	1·3	1·6	July 10	0·2	0·5	0·8	1·0	1·3	1·6
20	0·4	0·7	1·1	1·4	1·8	2·2	20	0·4	0·7	1·1	1·4	1·8	2·2
30	0·5	1·0	1·5	2·0	2·5	3·0	30	0·5	1·0	1·5	2·0	2·5	3·0
Feb. 10	0·6	1·1	1·6	2·2	2·8	3·4	Aug. 10	0·5	1·1	1·7	2·3	2·8	3·4
20	0·6	1·2	1·9	2·5	3·1	3·7	20	0·6	1·3	1·9	2·5	3·2	3·9
28	0·7	1·3	2·0	2·6	3·3	4·0	30	0·7	1·4	2·0	2·7	3·4	4·1
Mar. 10	0·7	1·4	2·1	2·8	3·5	4·2	Sept. 10	0·7	1·4	2·1	2·8	3·5	4·2
20	0·7	1·4	2·1	2·8	3·6	4·3	20	0·7	1·4	2·1	2·9	3·6	4·3
	add	*add*	*add*	*add*	*add*	*add*		*add*	*add*	*add*	*add*	*add*	*add*
30	0·7	1·4	2·1	2·8	3·5	4·2	30	0·7	1·4	2·1	2·8	3·5	4·2
Apr. 10	0·7	1·4	2·1	2·7	3·4	4·1	Oct. 10	0·7	1·4	2·0	2·7	3·4	4·1
20	0·6	1·3	1·9	2·5	3·2	3·9	20	0·6	1·3	1·9	2·5	3·2	3·9
30	0·6	1·1	1·7	2·3	2·8	3·4	30	0·5	1·1	1·6	2·2	2·8	3·4
May 10	0·5	0·9	1·5	2·0	2·5	3·0	Nov. 10	0·5	1·0	1·4	1·9	2·4	2·8
20	0·4	0·8	1·2	1·6	1·9	2·3	20	0·4	0·8	1·2	1·5	2·0	2·5
30	0·3	0·5	0·8	1·0	1·4	1·7	30	0·2	0·5	0·7	1·0	1·3	1·6
June 10	0·2	0·3	0·4	0·5	0·7	0·9	Dec. 10	0·2	0·3	0·4	0·6	0·7	0·8
20	0·0	0·0	0·1	0·1	0·1	0·1	20	0·0	0·0	0·1	0·1	0·2	0·3
	sub.	*sub.*	*sub.*	*sub.*	*sub*	*sub.*		*sub.*	*sub.*	*sub.*	*sub.*	*sub.*	*sub.*
30	0·1	0·3	0·4	0·6	0·7	0·8	30	0·1	0·3	0·4	0·6	0·7	0·9

SIDEREAL TIME, FOR THE YEAR 1901,
At Mean Noon at Greenwich.

Day	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
1	18 41·8	20 44	22 34·4	0 36·6	2 34·9	4 37·1	6 35·4	8 37·6	10 39·8	12 38·1	14 40·3	16 38·6
2	18 45·7	20 47·9	22 38·3	0 40·5	2 38·8	4 41	6 39·3	8 41·5	10 43·8	12 42	14 44·3	16 42·5
3	18 49·7	20 51·9	22 42·3	0 44·5	2 42·8	4 45	6 43·3	8 45·5	10 47·7	12 46	14 48·2	16 46·5
4	18 53·6	20 55·8	22 46·2	0 48·4	2 46·7	4 48·9	6 47·2	8 49·4	10 51·6	12 49·9	14 52·1	16 50·4
5	18 57·5	20 59·8	22 50·2	0 52·4	2 50·6	4 52·9	6 51·1	8 53·4	10 55·6	12 53·9	14 56·1	16 54·4
6	19 1·5	21 3·7	22 54·1	0 56·3	2 54·6	4 56·8	6 55·1	8 57·3	10 59·5	12 57·8	15 0	16 58·3
7	19 5·4	21 7·6	22 58	1 0·3	2 58·5	5 0·8	6 59	9 1·3	11 3·5	13 1·7	15 4	17 2·2
8	19 9·4	21 11·6	23 2	1 4·2	3 2·5	5 4·7	7 3	9 5·2	11 7·4	13 5·7	15 7·9	17 6·2
9	19 13·3	21 15·5	23 5·9	1 8·1	3 6·4	5 8·6	7 6·9	9 9·1	11 11·4	13 9·6	15 11·9	17 10·1
10	19 17·3	21 19·5	23 9·9	1 12·1	3 10·4	5 12·6	7 10·9	9 13·1	11 15·3	13 13·6	15 15·8	17 14·1
11	19 21·2	21 23·4	23 13·8	1 16	3 14·3	5 16·5	7 14·8	9 17	11 19·2	13 17·5	15 19·7	17 18
12	19 25·1	21 27·4	23 17·7	1 20	3 18·2	5 20·5	7 18·7	9 21	11 23·2	13 21·5	15 23·7	17 22
13	19 29·1	21 31·3	23 21·7	1 23·9	3 22·2	5 24·4	7 22·7	9 24·9	11 27·1	13 25·4	15 27·6	17 25·9
14	19 33	21 35·2	23 25·6	1 27·9	3 26·1	5 28·3	7 26·6	9 28·8	11 31·1	13 29·3	15 31·6	17 29·8
15	19 37	21 39·2	23 29·6	1 31·8	3 30·1	5 32·3	7 30·6	9 32·8	11 35	13 33·3	15 35·5	17 33·8
16	19 40·9	21 43·1	23 33·5	1 35·7	3 34	5 36·2	7 34·5	9 36·7	11 39	13 37·2	15 39·4	17 37·7
17	19 44·8	21 47·1	23 37·5	1 39·7	3 38	5 40·2	7 38·5	9 40·7	11 42·9	13 41·2	15 43·4	17 41·7
18	19 48·8	21 51	23 41·4	1 43·6	3 41·9	5 44·1	7 42·4	9 44·6	11 46·8	13 45·1	15 47·3	17 45·6
19	19 52·7	21 54	23 45·3	1 47·6	3 45·8	5 48·1	7 46·3	9 48·6	11 50·8	13 49·1	15 51·3	17 49·6
20	19 56·7	21 58·9	23 49·3	1 51·5	3 49·8	5 52	7 50·3	9 52·5	11 54·7	13 53	15 55·2	17 53·5
21	20 0·6	22 2·8	23 53·2	1 55·4	3 53·7	5 55·9	7 54·2	9 56·4	11 58·7	13 56·9	15 59·2	17 57·4
22	20 4·6	22 6·8	23 57·2	1 59·4	3 57·7	5 59·9	7 58·2	10 0·4	12 2·6	14 0·9	16 3·1	18 1·4
23	20 8·5	22 10·7	0 1·1	2 3·3	4 1·6	6 3·8	8 2·1	10 4·3	12 6·6	14 4·8	16 7	18 5·3
24	20 12·4	22 14·7	0 5·1	2 7·3	4 5·6	6 7·8	8 6·1	10 8·3	12 10·5	14 8·8	16 11	18 9·3
25	20 16·4	22 18·6	0 9	2 11·2	4 9·5	6 11·7	8 10	10 12·2	12 14·4	14 12·7	16 14·9	18 13·2
26	20 20·3	22 22·6	0 12·9	2 15·2	4 13·4	6 15·7	8 13·9	10 16·2	12 18·4	14 16·7	16 18·9	18 17·2
27	20 24·3	22 26·5	0 16·9	2 19·1	4 17·4	6 19·6	8 17·9	10 20·1	12 22·3	14 20·6	16 22·8	18 21·1
28	20 28·2	22 30·4	0 20·8	2 23	4 21·3	6 23·5	8 21·8	10 24	12 26·3	14 24·5	16 26·8	18 25
29	20 32·2		0 24·8	2 27	4 25·3	6 27·5	8 25·8	10 28	12 30·2	14 28·5	16 30·7	18 29
30	20 36·1		0 28·7	2 30·9	4 29·2	6 31·4	8 29·7	10 31·9	12 34·1	14 32·4	16 34·6	18 32·9
31	20 40		0 32·7		4 33·2		8 33·7	10 35·9		14 36·4		18 36·9

SIDEREAL TIME, FOR 1902.

Day	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	18 40·8	20 43	22 33·4	0 35·6	2 33·9	4 36·1	6 34·4	8 36·6	10 38·9	12 37·1	14 39·3	16 37·6
2	18 44·8	20 47	22 37·4	0 39·6	2 37·9	4 40·1	6 38·4	8 40·6	10 42·8	12 41·1	14 43·3	16 41·6
3	18 48·7	20 50·9	22 41·3	0 43·5	2 41·8	4 44	6 42·3	8 44·5	10 46·7	12 45	14 47·2	16 45·5
4	18 52·6	20 54·9	22 45·2	0 47·5	2 45·7	4 48	6 46·2	8 48·5	10 50·7	12 49	14 51·2	16 49·5
5	18 56·6	20 58·8	22 49·2	0 51·4	2 49·7	4 51·9	6 50·2	8 52·4	10 54·6	12 52·9	14 55·1	16 53·4
6	19 0·5	21 2·7	22 53·1	0 55·4	2 53·6	4 55·8	6 54·1	8 56·3	10 58·6	12 56·8	14 59·1	16 57·3
7	19 4·5	21 6·7	22 57·1	0 59·3	2 57·6	4 59·8	6 58·1	9 0·3	11 2·5	13 0·8	15 3	17 1·3
8	19 8·4	21 10·6	23 1	1 3·2	3 1·5	5 3·7	7 2	9 4·2	11 6·5	13 4·7	15 6·9	17 5·2
9	19 12·3	21 14·6	23 5	1 7·2	3 5·5	5 7·7	7 6	9 8·2	11 10·4	13 8·7	15 10·9	17 9·2
10	19 16·3	21 18·5	23 8·9	1 11·1	3 9·4	5 11·6	7 9·9	9 12·1	11 14·3	13 12·6	15 14·8	17 13·1
11	19 20·2	21 22·5	23 12·8	1 15·1	3 13·3	5 15·6	7 13·8	9 16·1	11 18·3	13 16·6	15 18·8	17 17·1
12	19 24·2	21 26·4	23 16·8	1 19	3 17·3	5 19·5	7 17·8	9 20	11 22·2	13 20·5	15 22·7	17 21
13	19 28·1	21 30·3	23 20·7	1 23	3 21·2	5 23·4	7 21·7	9 23·9	11 26·2	13 24·4	15 26·7	17 24·9
14	19 32·1	21 34·3	23 24·7	1 26·9	3 25·2	5 27·4	7 25·7	9 27·9	11 30·1	13 28·4	15 30·6	17 28·9
15	19 36	21 38·2	23 28·6	1 30·8	3 29·1	5 31·3	7 29·6	9 31·8	11 34·1	13 32·3	15 34·5	17 32·8
16	19 39·9	21 42·2	23 32·6	1 34·8	3 33·1	5 35·3	7 33·6	9 35·8	11 38	13 36·3	15 38·5	17 36·8
17	19 43·9	21 46·1	23 36·5	1 38·7	3 37	5 39·2	7 37·5	9 39·7	11 41·9	13 40·2	15 42·4	17 40·7
18	19 47·8	21 50·1	3 40·4	1 42·7	3 40·9	5 43·2	7 41·4	9 43·7	11 45·9	13 44·2	15 46·4	17 44·7
19	19 51·8	21 54	23 44·4	1 46·6	3 44·9	5 47·1	7 45·4	9 47·6	11 49·8	13 48·1	15 50·3	17 48·6
20	19 55·7	21 57·9	23 48·3	1 50·5	3 48·8	5 51	7 49·3	9 51·5	11 53·8	13 52	15 54·3	17 52·5
21	19 59·7	22 1·9	23 52·3	1 54·5	3 52·8	5·55	7 53·3	9 55·5	11 57·7	13 56	15 58·2	17 56·5
22	20 3·6	22 5·8	23 56·2	1 58·4	3 56·7	5 58·9	7 57·2	9 59·4	12 1·6	13 59·9	16 2·1	18 0·4
23	20 7·5	22 9·8	0 0·2	2 2·4	4 0·7	6 2·9	8 1·2	10 3·4	12 5·6	14 3·9	16 6·1	18 4·4
24	20 11·5	22 13·7	0 4·1	2 6·3	4 4·6	6 6·8	8 5·1	10 7·3	12 9·5	14 7·8	16 10	18 8·3
25	20 15·4	22 17·7	0 8	2 10·3	4 8·5	6 10·8	8 9	10 11·3	12 13·5	14 11·8	16 14	18 12·3
26	20 19·4	22 21·6	0 12	2 14·2	4 12·5	6 14·7	8 13	10 15·2	12 17·4	14 15·7	16 17·9	18 16·2
27	20 23·3	22 25·5	0 15·9	2 18·1	4 16·4	6 18·6	8 16·9	10 19·1	12 21·4	14 19·6	16 21·9	18 20·1
28	20 27·3	22 29·5	0 19·9	2 22·1	4 20·4	6 22·6	8 20·9	10 23·1	12 25·3	14 23·6	16 25·8	18 24·1
29	20 31·2		0 23·8	2 26	4 24·3	6 26·5	8 24·8	10 27	12 29·2	14 27·5	16 29·7	18 28
30	20 35·1		0 27·7	2 30	4 28·3	6 30·5	8 28·8	10 31	12 33·2	14 31·5	16 33·7	18 32
31	20 39·1		0 31·7		4 32·2		8 32·7	10 34·9		14 35·4		18 35·9

SIDEREAL TIME, for the Year 1903,

At Mean Noon at Greenwich.

Day	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
1	18 39·8	20 42·1	22 32·5	0 34·7	2 33·0	4 35·2	6 33·5	8 35·7	10 37·9	12 36·2	14 38·4	16 36·7
2	18 43·8	20 46·0	22 36·4	0 38·6	2 36·9	4 39·1	6 37·4	8 39·6	10 41·8	12 40·1	14 42·3	16 40·6
3	18 47·7	20 50·0	22 40·3	0 42·6	2 40·8	4 43·1	6 41·3	8 43·6	10 45·8	12 44·1	14 46·3	16 44·6
4	18 51·7	20 53·9	22 44·3	0 46·5	2 44·8	4 47·0	6 45·3	8 47·5	10 49·7	12 48·0	14 50·2	16 48·5
5	18 55·6	20 57·8	22 48·2	0 50·4	2 48·7	4 50·9	6 49·2	8 51·4	10 53·7	12 51·9	14 54·2	16 52·4
6	18 59·6	21 1·8	22 52·2	0 54·4	2 52·7	4 54·9	6 53·2	8 55·4	10 57·6	12 55·9	14 58·1	16 56·4
7	19 3·5	21 5·7	22 56·1	0 58·3	2 56·6	4 58·8	6 57·1	8 59·3	11 1·5	12 59·8	15 2·1	17 0·3
8	19 7·4	21 9·7	23 0·1	1 2·3	3 0·6	5 2·8	7 1·1	9 3·3	11 5·5	13 3·8	15 6·0	17 4·3
9	19 11·4	21 13·6	23 4·0	1 6·2	3 4·5	5 6·7	7 5·0	9 7·2	11 9·4	13 7·7	15 9·9	17 8·2
10	19 15·3	21 17·6	23 7·9	1 10·2	3 8·4	5 10·7	7 8·9	9 11·2	11 13·4	13 11·7	15 13·9	17 12·2
11	19 19·3	21 21·5	23 11·9	1 14·1	3 12·4	5 14·6	7 12·9	9 15·1	11 17·3	13 15·6	15 17·8	17 16·1
12	19 23·2	21 25·4	23 15·8	1 18·0	3 16·3	5 18·5	7 16·8	9 19·0	11 21·3	13 19·5	15 21·8	17 20·0
13	19 27·2	21 29·4	23 19·8	1 22·0	3 20·3	5 22·5	7 20·8	9 23·0	11 25·2	13 23·5	15 25·7	17 24·0
14	19 31·1	21 33·3	23 23·7	1 25·9	3 24·2	5 26·4	7 24·7	9 26·9	11 29·1	13 27·4	15 29·6	17 27·9
15	19 35·0	21 37·3	23 27·7	1 29·9	3 28·2	5 30·4	7 28·7	9 30·9	11 33·1	13 31·4	15 33·6	17 31·9
16	19 39·0	21 41·2	23 31·6	1 33·8	3 32·1	5 34·3	7 32·6	9 34·8	11 37·0	13 35·3	15 37·5	17 35·8
17	19 42·9	21 45·2	23 35·5	1 37·8	3 36·0	5 38·3	7 36·5	9 38·8	11 41·0	13 39·3	15 41·5	17 39·7
18	19 46·9	21 49·1	23 39·5	1 41·7	3 40·0	5 42·2	7 40·5	9 42·7	11 44·9	13 43·2	15 45·4	17 43·7
19	19 50·8	21 53·0	23 43·4	1 45·6	3 43·9	5 46·1	7 44·4	9 46·6	11 48·9	13 47·1	15 49·4	17 47·6
20	19 54·8	21 57·0	23 47·4	1 49·6	3 47·9	5 50·1	7 48·4	9 50·6	11 52·8	13 51·1	15 53·3	17 51·6
21	19 58·7	22 0·9	23 51·3	1 53·5	3 51·8	5 54·0	7 52·3	9 54·5	11 56·7	13 55·0	15 57·2	17 55·5
22	20 2·6	22 4·9	23 55·3	1 57·5	3 55·8	5 58·0	7 56·2	9 58·5	12 0·7	13 59·0	16 1·2	17 59·5
23	20 6·6	22 8·8	23 59·2	2 1·4	3 59·7	6 1·9	8 0·2	10 2·4	12 4·6	14 2·9	16 5·1	18 3·4
24	20 10·5	22 12·7	0 3·1	2 5·4	4 3·6	6 5·9	8 4·2	10 6·4	12 8·6	14 6·8	16 9·1	18 7·3
25	20 14·5	22 16·7	0 7·1	2 9·3	4 7·6	6 9·8	8 8·1	10 10·3	12 12·5	14 10·8	16 13·0	18 11·3
26	20 18·4	22 20·6	0 11·0	2 13·2	4 11·5	6 13·7	8 12·0	10 14·2	12 16·5	14 14·7	16 17·0	18 15·2
27	20 22·4	22 24·6	0 15·0	2 17·2	4 15·5	6 17·7	8 16·0	10 18·2	12 20·4	14 18·7	16 20·9	18 19·2
28	20 26·3	22 28·5	0 18·9	2 21·1	4 19·4	6 21·6	8 19·9	10 22·1	12 24·3	14 22·6	16 24·8	18 23·1
29	20 30·2		0 22·9	2 25·1	4 23·3	6 25·6	8 23·8	10 26·1	12 28·3	14 26·6	16 28·8	18 27·1
30	20 34·2		0 26·8	2 29·0	4 27·3	6 29·5	8 27·8	10 30·0	12 32·2	14 30·5	16 32·7	18 31·0
31	20 38·1		0 30·7		4 31·2		8 31·7	10 34·0		14 34·4		18 34·9

Sidereal Time, for 1904.

Day	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	18 38·9	20 41·1	22 35·4	0 37·7	2 35·9	4 38·2	6 36·4	8 38·7	10 40·9	12 39·2	14 41·4	16 39·6
2	18 42·8	20 45·1	22 39·4	0 41·6	3 39·9	4 42·1	6 40·4	8 42·6	10 44·8	12 43·1	14 45·3	16 43·6
3	18 46·8	20 49·0	22 43·3	0 45·5	2 43·8	4 46·0	6 44·3	8 46·5	10 48·8	12 47·0	14 49·3	16 47·5
4	18 50·7	20 52·9	22 47·3	0 49·5	2 47·8	4 49·0	6 48·3	8 50·5	10 52·7	12 51·0	14 53·2	16 51·5
5	18 54·7	20 56·9	22 51·2	0 53·4	2 51·7	4 53·9	6 52·2	8 54·4	10 56·6	12 54·9	14 57·2	16 55·4
6	18 58·6	21 0·8	22 55·2	0 57·4	2 55·7	4 57·9	6 56·1	8 58·4	11 0·6	12 58·9	15 1·1	16 59·4
7	19 2·5	21 4·8	22 59·1	1 1·3	2 59·6	5 1·8	7 0·1	9 2·3	11 4·5	13 2·8	15 5·0	17 3·3
8	19 6·5	21 8·7	23 3·0	1 5·3	3 3·5	5 5·8	7 4·0	9 6·3	11 8·5	13 6·8	15 9·0	17 7·2
9	19 10·4	21 12·6	23 7·0	1 9·2	3 7·5	5 9·7	7 8·0	9 10·2	11 12·4	13 10·7	15 12·9	17 11·2
10	19 14·4	21 16·6	23 10·9	1 13·1	3 11·4	5 13·6	7 11·9	9 14·1	11 16·3	13 14·6	15 16·9	17 15·1
11	19 18·3	21 20·5	23 14·9	1 17·1	3 15·4	5 17·6	7 15·9	9 18·1	11 20·3	13 18·6	15 20·8	17 19·1
12	19 22·3	21 24·5	23 18·8	1 21·0	3 19·3	5 21·5	7 19·8	9 22·0	11 24·2	13 22·5	15 24·7	17 23·0
13	19 26·2	21 28·4	23 22·8	1 24·0	3 23·2	5 25·5	7 23·7	9 26·0	11 28·2	13 26·5	15 28·7	17 27·0
14	19 30·2	21 32·4	23 26·7	1 28·9	3 27·2	5 29·4	7 27·7	9 29·9	11 32·1	13 30·4	15 32·6	17 30·9
15	19 34·1	21 36·3	23 30·6	1 32·9	3 31·1	5 33·4	7 31·6	9 33·9	11 36·1	13 34·3	15 36·6	17 34·8
16	19 38·0	21 40·2	23 34·6	1 36·8	3 35·1	5 37·3	7 35·6	9 37·8	11 40·0	13 38·3	15 40·5	17 38·8
17	19 42·0	21 44·2	23 38·5	1 40·7	3 39·0	5 41·2	7 39·5	9 41·7	11 44·0	13 42·2	15 44·5	17 42·7
18	19 45·9	21 48·1	23 42·5	1 44·7	3 43·0	5 45·2	7 43·5	9 45·7	11 47·9	13 46·2	15 48·4	17 46·7
19	19 49·8	21 52·1	23 46·4	1 48·6	3 46·9	5 49·1	7 47·4	9 49·6	11 51·8	13 50·1	15 52·3	17 50·6
20	19 53·8	21 56·0	23 50·4	1 52·6	3 50·8	5 53·1	7 51·3	9 53·6	11 55·8	12 54·1	15 56·3	17 54·6
21	19 57·7	22 0·0	23 54·3	1 56·5	3 54·8	5 57·0	7 55·3	9 57·5	11 59·7	13 58·0	16 0·2	17 58·5
22	20 1·7	22 3·9	23 58·2	2 0·5	3 58·7	6 1·0	7 59·2	10 1·5	12 3·7	14 1·9	16 4·2	18 2·4
23	20 5·6	22 7·8	0 2·2	2 4·4	4 2·7	6 4·9	8 3·2	10 5·4	12 7·6	14 5·9	16 8·1	18 6·4
24	20 9·6	22 11·8	0 6·1	2 8·3	4 6·6	6 8·8	8 7·1	10 9·3	12 11·6	14 9·8	16 12·1	18 10·3
25	20 13·5	22 15·7	0 10 1	2 12·3	4 10·6	6 12·8	8 11·1	10 13·3	12 15·5	14 13·8	16 16·0	18 14·3
26	20 17·5	22 19·7	0 14·0	2 16·2	4 14·5	6 16·7	8 15·0	10 17·2	12 19·4	14 17·7	16 19·9	18 18·2
27	20 21·4	22 23·6	0 17·9	2 20·2	4 18·4	6 20·7	8 18·9	10 21·2	12 23·4	14 21·7	16 23·9	18 22·2
28	20 25·3	22 27·6	0 21·9	2 24·1	4 22·4	6 24·6	8 22·9	10 25·1	12 27·3	14 25·6	16 27·8	18 26·1
29	20 29·3	22 31 5	0 25·8	2 28·1	4 26·3	6 28·6	8 26·8	10 29·0	12 31·3	14 29·5	16 31·8	18 30·0
30	20 33·2		0 29·8	2 32·0	4 30·3	6 32·5	8 30·8	10 33·0	12 35·2	14 33·5	16 35·7	18 34·0
31	20 37·2		0 33·7		4 34·2		8 34·7	10 36·9		14 37·4		18 37·9

EQUATION OF TIME, FOR THE YEAR 1901,

For Apparent Noon at Greenwich.

Day	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	add	*add*	*add*		*sub*		*add*	*add*		*sub*	*sub.*	
1	3m 34s	13m 46s	12m 38s	*add* 4m 7s	2m 55s	*sub.* 2m 30s	3m 27s	6m 8s	*add* 0m 4s	10m 10s	16m 20s	*sub.* 11m 2s
2	4 2	13 53	12 26	3 49	3 3	2 21	3 39	6 4	*sub.* 0 15	10 30	16 21	10 40
3	4 30	14 0	12 14	3 30	3 10	2 12	3 50	6 0	0 35	10 49	16 22	10 16
4	4 58	14 6	12 1	3 13	3 17	2 2	4 1	5 55	0 54	11 7	16 21	9 53
5	5 25	14 12	11 48	2 55	3 22	1 52	4 12	5 50	1 14	11 25	16 20	9 28
6	5 52	14 16	11 34	2 37	3 28	1 42	4 22	5 44	1 33	11 43	16 18	9 3
7	6 18	14 20	11 20	2 20	3 33	1 31	4 32	5 37	1 54	12 1	16 16	8 38
8	6 44	14 23	11 5	2 3	3 37	1 20	4 42	5 30	2 14	12 18	16 12	8 11
9	7 9	14 25	10 50	1 46	3 41	1 9	4 51	5 23	2 34	12 34	16 8	7 45
10	7 34	14 26	10 34	1 29	3 44	0 57	5 0	5 14	2 55	12 50	16 2	7 18
11	7 58	14 27	10 19	1 13	3 46	0 45	5 9	5 6	3 15	13 6	15 56	6 50
12	8 22	14 27	10 3	0 56	3 48	0 33	5 17	4 56	3 36	13 21	15 49	6 22
13	8 45	14 26	9 46	0 41	3 49	0 21	5 24	4 46	3 57	13 36	15 41	5 54
14	9 7	14 24	9 30	0 25	3 50	*sub.* 0 8	5 32	4 36	4 18	13 50	15 33	5 26
15	9 29	14 22	9 13	*add* 0 10	3 50	*add* 0 4	5 38	4 25	4 39	14 4	15 23	4 57
16	9 50	14 19	8 56	*sub.* 0 5	3 49	0 17	5 45	4 13	5 0	14 17	15 13	4 28
17	10 10	14 15	8 39	0 19	3 48	0 30	5 50	4 1	5 21	14 29	15 1	3 58
18	10 30	14 11	8 21	0 33	3 47	0 43	5 56	3 49	5 43	14 41	14 49	3 29
19	10 49	14 6	8 4	0 46	3 45	0 56	6 0	3 35	6 4	14 53	14 37	2 59
20	11 8	14 0	7 46	1 0	3 42	1 9	6 5	3 22	6 25	15 3	14 23	2 29
21	11 25	13 53	7 28	1 12	3 38	1 22	6 8	3 8	6 46	15 14	14 8	2 0
22	11 42	13 46	7 10	1 25	3 35	1 35	6 11	2 53	7 7	15 23	13 53	1 30
23	11 58	13 38	6 52	1 37	3 30	1 48	6 14	2 38	7 28	15 32	13 37	1 0
24	12 13	13 30	6 34	1 48	3 26	2 1	6 15	2 22	7 49	15 40	13 21	0 30
25	12 28	13 21	6 15	1 59	3 20	2 14	6 17	2 6	8 10	15 48	13 3	*sub.* 0 0
26	12 41	13 11	5 57	2 10	3 14	2 27	6 17	1 50	8 30	15 54	12 45	*add* 0 30
27	12 54	13 1	5 39	2 20	3 8	2 39	6 17	1 33	8 51	16 1	12 26	0 59
28	13 6	12 50	5 20	2 30	3 1	2 52	6 17	1 16	9 11	16 6	12 6	1 29
29	13 17		5 2	2 39	2 54	3 4	6 15	0 58	9 31	16 11	11 45	1 58
30	13 28		4 43	2 47	2 47	3 16	6 14	0 40	9 51	16 14	11 24	2 27
31	13 37		4 25		2 38		6 11	0 22		16 17		2 56

EQUATION OF TIME, FOR 1902.

Day	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	add	*add*	*add*		*sub.*		*add*	*add*		*sub.*	*sub.*	
1	3m 25s	13m 42s	12m 40s	*add* 4m 10s	2m 54s	*sub.* 2m 32s	3m 25s	6m 10s	*add* 0m 10s	10m 4s	16m 18s	*sub.* 11m 7s
2	3 53	13 50	12 28	3 52	3 2	2 23	3 37	6 7	*sub* 0 9	10 23	16 19	10 45
3	4 22	13 57	12 16	3 34	3 9	2 14	3 49	6 3	0 28	10 42	16 20	10 22
4	4 49	14 4	12 3	3 16	3 15	2 4	4 0	5 58	0 47	11 1	16 20	9 58
5	5 17	14 9	11 50	2 59	3 21	1 54	4 11	5 53	1 7	11 19	16 19	9 34
6	5 44	14 14	11 36	2 41	3 26	1 43	4 21	5 48	1 26	11 37	16 18	9 9
7	6 10	14 18	11 22	2 24	3 31	1 32	4 32	5 41	1 46	11 54	16 15	8 43
8	6 36	14 22	11 8	2 7	3 35	1 21	4 42	5 34	2 7	12 12	16 12	8 17
9	7 2	14 24	10 53	1 50	3 39	1 10	4 51	5 27	2 27	12 28	16 8	7 51
10	7 27	14 26	10 38	1 33	3 42	0 58	5 0	5 19	2 48	12 45	16 3	7 24
11	7 51	14 27	10 22	1 17	3 44	0 46	5 9	5 10	3 8	13 1	15 57	6 57
12	8 15	14 27	10 7	1 1	3 46	0 34	5 17	5 1	3 29	13 16	15 50	6 30
13	8 38	14 26	9 50	0 45	3 48	0 22	5 25	4 51	3 50	13 31	15 43	6 2
14	9 1	14 25	9 34	0 30	3 49	*sub* 0 10	5 32	4 40	4 11	13 45	15 34	5 33
15	9 23	14 22	9 17	*add* 0 14	3 49	*add* 0 3	5 39	4 29	4 33	13 59	15 25	5 5
16	9 44	14 19	9 0	*sub.* 0 0	3 49	0 15	5 45	4 18	4 54	14 13	15 15	4 36
17	10 5	14 16	8 43	0 15	3 48	0 28	5 51	4 6	5 15	14 26	15 5	4 7
18	10 25	14 11	8 26	0 29	3 46	0 41	5 56	3 53	5 37	14 38	14 53	3 38
19	10 44	14 6	8 8	0 43	3 44	0 54	6 0	3 40	5 58	14 50	14 40	3 8
20	11 2	14 0	7 50	0 56	3 42	1 7	6 5	3 26	6 19	15 1	14 27	2 38
21	11 20	13 54	7 32	1 9	3 39	1 20	6 8	3 12	6 40	15 11	14 13	2 8
22	11 37	13 47	7 14	1 22	3 35	1 33	6 11	2 57	7 1	15 21	13 58	1 39
23	11 53	13 39	6 56	1 34	3 31	1 46	6 14	2 42	7 22	15 30	13 42	1 9
24	12 8	13 30	6 37	1 46	3 27	1 58	6 16	2 27	7 43	15 38	13 25	0 39
25	12 23	13 41	6 19	1 57	3 22	2 11	6 17	2 11	8 4	15 46	13 8	*sub.* 0 9
26	12 36	13 12	6 0	2 8	3 16	2 24	6 18	1 55	8 25	15 53	12 49	*add* 0 21
27	12 49	13 2	5 42	2 18	3 10	2 37	6 18	1 38	8 45	15 59	12 30	0 51
28	13 1	12 51	5 23	2 28	3 3	2 49	6 18	1 21	9 5	16 4	12 11	1 21
29	13 13		5 5	2 37	2 56	3 1	6 17	1 4	9 25	16 9	11 50	1 50
30	13 23		4 47	2 46	2 48	3 13	6 15	0 46	9 45	16 13	11 29	2 20
31	13 33		4 28		2 40		6 13	0 28		16 16		2 49

EQUATION OF TIME, FOR THE YEAR 1903,
For Apparent Noon at Greenwich.

Day	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec
1	add $3^{m}18^{s}$	add $13^{m}39^{s}$	add $12^{m}42^{s}$	add $4^{m}15^{s}$	sub. $2^{m}51^{s}$	sub. $2^{m}33^{s}$	add $3^{m}24^{s}$	add $6^{m}12^{s}$	add $0^{m}14^{s}$	sub. $9^{m}59^{s}$	sub $16^{m}17^{s}$	sub. $11^{m}12^{s}$
2	3 46	13 47	12 31	3 57	2 59	2 24	3 35	6 8	sub 0 4	10 19	16 19	10 50
3	4 15	13 55	12 19	3 39	3 6	2 15	3 47	6 4	0 23	10 38	16 20	10 27
4	4 42	14 2	12 6	3 21	3 13	2 5	3 58	6 0	0 43	10 57	16 21	10 4
5	5 10	14 8	11 53	3 3	3 19	1 55	4 9	5 55	1 2	11 15	16 20	9 40
6	5 37	14 13	11 40	2 46	3 24	1 45	4 19	5 49	1 22	11 33	16 19	9 15
7	6 3	14 17	11 26	2 28	3 29	1 35	4 29	5 43	1 42	11 51	16 16	8 50
8	6 29	14 20	11 11	2 11	3 34	1 24	4 39	5 36	2 2	12 8	16 13	8 24
9	6 55	14 23	10 56	1 54	3 38	1 13	4 49	5 28	2 23	12 25	16 9	7 58
10	7 20	14 24	10 41	1 37	3 41	1 1	4 58	5 20	2 44	12 42	16 5	7 31
11	7 44	14 25	10 26	1 21	3 44	0 49	5 6	5 11	3 4	12 58	15 59	7 4
12	8 8	14 25	10 10	1 4	3 46	0 37	5 14	5 2	3 25	13 13	15 53	6 37
13	8 31	14 25	9 54	0 48	3 48	0 25	5 22	4 52	3 46	13 28	15 45	6 9
14	8 54	14 23	9 37	0 33	3 49	0 13	5 29	4 42	4 7	13 43	15 37	5 40
15	9 16	14 21	9 20	0 17	3 49	sub. 0 1	5 36	4 31	4 28	13 57	15 28	5 12
16	9 37	14 18	9 3	add 0 2	3 49	add 0 12	5 43	4 20	4 50	14 10	15 18	4 43
17	9 58	14 15	8 46	sub. 0 12	3 48	0 25	5 49	4 8	5 11	14 23	15 7	4 14
18	10 18	14 11	8 29	0 27	3 47	0 38	5 54	3 56	5 32	14 35	14 55	3 44
19	10 37	14 6	8 11	0 41	3 45	0 51	5 59	3 43	5 53	14 47	14 43	3 14
20	10 56	14 0	7 53	0 54	3 43	1 4	6 3	3 29	6 14	14 58	14 30	2 45
21	11 14	13 54	7 35	1 7	3 40	1 17	6 7	3 15	6 35	15 8	14 15	2 15
22	11 31	13 47	7 17	1 20	3 36	1 30	6 10	3 1	6 56	15 18	14 0	1 45
23	11 47	13 40	6 59	1 32	3 32	1 43	6 13	2 46	7 17	15 27	13 45	1 15
24	12 3	13 32	6 41	1 43	3 28	1 56	6 16	2 31	7 38	15 35	13 28	0 45
25	12 18	13 23	6 23	1 54	3 23	2 9	6 17	2 15	7 59	15 43	13 11	sub. 0 15
26	12 32	13 14	6 4	2 5	3 17	2 22	6 18	1 59	8 19	15 50	12 53	add 0 15
27	12 45	13 4	5 46	2 15	3 11	2 34	6 19	1 43	8 40	15 57	12 34	0 45
28	12 57	12 53	5 28	2 25	3 4	2 47	6 19	1 26	9 0	16 2	12 15	1 15
29	13 9		5 10	2 34	2 57	2 59	6 18	1 9	9 20	16 7	11 55	1 44
30	13 20		4 51	sub 2 43	2 49	add 3 12	6 16	0 51	sub 9 40	16 11	11 34	2 13
31	add 13 30		4 33		2 41		6 14	add 0 33		16 15		add 2 42

EQUATION OF TIME, FOR 1904.

Day	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec
1	add $3^{m}11^{s}$	add $13^{m}37^{s}$	add $12^{m}34^{s}$	add $4^{m}1^{s}$	sub. $2^{m}57^{s}$	sub. $2^{m}27^{s}$	add $3^{m}32^{s}$	add $6^{m}8^{s}$	sub. $0^{m}1^{s}$	sub. $10^{m}16^{s}$	sub. $16^{m}20^{s}$	sub. $10^{m}56^{s}$
2	3 40	13 45	12 22	3 43	3 4	2 18	3 43	6 4	0 20	10 35	16 21	10 34
3	4 8	13 53	12 9	3 25	3 11	2 8	3 54	6 0	0 39	10 53	16 21	10 10
4	4 35	14 0	11 56	3 7	3 18	1 58	4 5	5 55	0 59	11 12	16 21	9 46
5	5 3	14 6	11 43	2 50	3 24	1 48	4 16	5 49	1 18	11 30	16 20	9 21
6	5 30	14 11	11 29	2 32	3 29	1 38	4 26	5 43	1 38	11 48	16 17	8 56
7	5 57	14 15	11 14	2 15	3 33	1 27	4 36	5 37	1 58	12 5	16 14	8 30
8	6 23	14 19	11 0	1 58	3 37	1 16	4 46	5 29	2 19	12 22	16 10	8 4
9	6 48	14 22	10 45	1 41	3 40	1 4	4 55	5 21	2 39	12 38	16 6	7 37
10	7 13	14 24	10 29	1 25	3 43	0 52	5 4	5 13	3 0	12 54	16 0	7 10
11	7 38	14 25	10 14	1 8	3 45	0 40	5 12	5 4	3 20	13 10	15 54	6 43
12	8 2	14 25	9 58	0 52	3 47	0 28	5 20	4 55	3 41	13 25	15 47	6 15
13	8 26	14 25	9 41	0 37	3 48	0 16	5 28	4 45	4 2	13 39	15 39	5 47
14	8 49	14 24	9 25	0 22	3 49	sub. 0 3	5 35	4 34	4 23	13 53	15 30	5 18
15	9 11	14 22	9 8	add 0 7	3 49	add 0 10	5 42	4 23	4 44	14 7	15 20	4 49
16	9 33	14 20	8 51	sub. 0 8	3 48	0 22	5 48	4 11	5 6	14 20	15 10	4 20
17	9 54	14 17	8 34	0 22	3 47	0 35	5 53	3 59	5 27	14 32	14 58	3 51
18	10 14	14 13	8 16	0 36	3 45	0 48	5 58	3 46	5 48	14 44	14 46	3 22
19	10 34	14 8	7 59	0 50	3 42	1 1	6 3	3 33	6 9	14 55	14 33	2 52
20	10 53	14 3	7 41	1 3	3 39	1 14	6 7	3 19	6 30	15 6	14 19	2 22
21	11 11	13 57	7 23	1 15	3 36	1 27	6 10	3 4	6 52	15 16	14 5	1 52
22	11 28	13 50	7 5	1 27	3 32	1 40	6 13	2 50	7 13	15 26	13 49	1 23
23	11 44	13 43	6 47	1 39	3 28	1 53	6 15	2 34	7 34	15 34	13 33	0 53
24	12 0	13 35	6 28	1 51	3 23	2 6	6 17	2 18	7 55	15 42	13 16	sub. 0 23
25	12 15	13 26	6 10	2 2	3 18	2 19	6 18	2 2	8 15	15 50	12 58	add 0 7
26	12 29	13 17	5 52	2 12	3 12	2 31	6 18	1 46	8 36	15 56	12 40	0 37
27	12 43	13 7	5 33	2 22	3 5	2 44	6 18	1 29	8 56	16 2	12 21	1 6
28	12 55	12 56	5 15	2 32	2 58	2 56	6 17	1 12	9 16	16 7	12 1	1 36
29	13 7	12 45	4 56	2 41	2 51	3 8	6 16	0 54	9 36	16 12	11 40	2 5
30	13 18		4 38	sub. 2 49	2 43	add 3 20	6 14	0 36	sub 9 56	16 15	11 18	2 34
31	add 13 28		4 20		2 35		6 11	add 0 18		16 18		add 3 3

MEAN PLACES OF THE PRINCIPAL FIXED STARS FOR JAN. 1ST, 1900.

Name		Mag.	Right Asc. h m s	Ann. Var. s	Declination ° ′ ″	Ann. Var ″
α Andromedæ	*Alpheratz*	2	0 3 13	+ 3·09	28 32 18 N.	+ 19·9
γ Pegasi	*Algenib*	3	0 8 5	3·08	14 37 39 N.	+ 20·0
α Phœnicis	....	2	0 21 20	2·97	42 50 57 S.	− 19·5
α Cassiopeæ	*Schedar*	var.	0 34 50	3·37	55 59 19 N.	+ 19·8
β Ceti	*Denib Kaitos*	2	0 38 34	3·01	18 32 8 S.	− 19·8
α Ursæ Minoris	*Polaris*	2	1 22 33	25·31	88 46 27 N.	+ 18·8
α Eridani	*Achernar*	1	1 33 59	2·24	57 44 41 S.	− 18·3
γ Andromedæ	*Almach*	2	1 57 45	3·66	41 51 0 N.	+ 17·4
α Arietis	*Hamel*	2	2 1 32	3·37	22 59 25 N.	+ 17·2
α Ceti	*Menkar*	2, 3	2 57 3	3·13	3 41 51 N.	+ 14·3
α Persei	*Mirfak*	2	3 17 11	+ 4·26	49 30 19 N.	+ 13·1
α Tauri	*Aldebaran*	1	4 30 11	3·44	16 18 30 N.	+ 7·5
α Aurigæ	*Capella*	1	5 9 18	4·43	45 53 47 N.	+ 4·0
β Orionis	*Rigel*	1	5 9 44	2·88	8 19 1 S.	− 4·4
β Tauri	*Nath*	2	5 19 58	3·79	28 31 23 N.	+ 3·3
δ Orionis	....	2	5 26 54	3·06	0 22 23 S.	− 2·9
ε Orionis	*Alnilam*	2	5 31 8	3·04	1 15 57 S.	− 2·5
α Columbæ	*Phact*	2	5 36 2	2·18	34 7 38 S.	− 2·1
α Orionis	*Betelguese*	var.	5 49 45	3·25	7 23 19 N.	+ 1·0
β Aurigæ	*Menkalinan*	2	5 52 12	4·40	44 56 14 N.	+ 6·7
α Argûs	*Canopus*	1	6 21 44	+ 1·33	52 38 27 S.	+ 1·9
γ Geminorum	*Alhena*	2	6 31 56	3·47	16 29 5 N.	− 2·8
α Canis Majoris	*Sirius*	1	6 40 44	2·64	16 34 43 S.	+ 4·7
ε Canis Majoris	*Adara*	1, 2	6 54 42	2·36	28 50 9 S.	+ 4·7
α² Geminorum	*Castor*	2	7 28 13	3·84	32 6 29 N.	− 7·6
α Canis Minoris	*Procyon*	1	7 34 4	3·14	5 28 52 N.	− 9·0
β Geminorum	*Pollux*	1	7 39 12	3·68	28 16 4 N.	− 8·4
ζ Argûs	....	2	8 0 4	2·11	39 43 16 S.	+ 10·0
δ Argûs	....	2	8 41 57	1·65	54 20 32 S.	+ 15·0
α Hydræ	*Alphard*	2	9 22 40	2·95	8 13 30 S.	+ 15·4
α Leonis	*Regulus*	1, 2	10 3 3	+ 3·20	12 27 22 N.	− 17·5
γ¹ Leonis	*Algeiba*	2	10 14 28	3·31	20 20 50 N.	− 18·1
η Argûs	....	var.	10 41 11	2·32	59 9 30 S.	+ 18·9
α Ursæ Majoris	*Dubhe*	2	10 57 34	3·74	62 17 27 N	− 19·4
δ Leonis	*Zosma*	2, 3	11 8 47	3·20	21 4 18 N.	− 19·7
β Leonis	*Denebola*	2	11 43 58	3·06	15 7 52 N.	− 20·1
γ Ursæ Majoris	*Phecda*	2, 3	11 48 34	3·18	54 15 3 N.	− 20·0
α¹ Crucis	....	1	12 21 2	3·30	62 32 41 S.	+ 20·0
β Corvi	....	2, 3	12 29 8	3·14	22 50 38 S.	+ 20·0
α Canum Venaticorum	......	3	12 51 21	2·81	38 51 30 N.	− 19·5
α Virginis	*Spica*	1	13 19 55	+ 3·15	10 38 22 S.	+ 18·9
η Ursæ Majoris	*Benetnasch*	2	13 43 36	2·37	49 48 44 N.	− 18·1
β Centauri	....	1	13 56 46	4·19	59 53 26 S.	+ 17·6
α Draconis	*Thuban*	3, 4	14 1 41	1·62	64 51 13 N.	− 17·3
α Boötis	*Arcturus*	1	14 11 6	2·73	19 42 11 N.	− 18·8
α² Centauri	....	1	14 32 49	4·05	60 25 10 S.	+ 15·0
α Libræ	*Zuben el Genubi*	3	14 45 21	+ 3·31	15 37 35 S.	+ 15·1
β Ursæ Minoris	*Kochab*	2	14 51 0	− 0·22	74 33 51 N.	− 14·7
β Libræ	*Zuben el Chamali*	2	15 11 37	+ 3·22	9 0 51 S.	+ 13·5
α Coronæ Borealis	*Alphacca*	2	15 30 27	2·54	27 3 4 N.	− 12·3
α Serpentis	*Unukalhai*	2, 3	15 39 20	+ 2·95	6 44 24 N.	− 11·5
β¹ Scorpii	....	3	15 59 37	3·48	19 31 55 S.	+ 10·1
α Scorpii	*Antares*	1, 2	16 23 16	3·67	26 12 36 S.	+ 8·3
α Trianguli Australis	......	2	16 38 4	6·31	68 50 39 S.	+ 7·1
β Draconis	*Alwaid*	3	17 28 10	1·35	52 22 31 N.	− 2·8
α Ophiuchi	*Ras Alhague*	2	17 30 17	2·78	12 37 58 N.	− 2·8
γ Draconis	*Rastaban*	2, 3	17 54 17	1·39	51 30 2 N.	− 0·5
α Lyræ	*Vega*	1	18 33 33	2·03	38 41 26 N.	+ 3·2
α Aquilæ	*Altair*	1	19 45 54	2·93	8 36 14 N.	+ 9·3
α Pavonis	....	2	20 17 44	4·78	57 3 20 S.	− 11·2
α Cygni	*Deneb*	1, 2	20 38 1	+ 2·04	44 55 22 N.	+ 12·7
α Cephei	*Alderamin*	2, 3	21 16 11	1·44	62 9 42 N.	+ 15·2
ε Pegasi	....	2, 3	21 39 16	2·95	9 24 59 N.	+ 16·4
α Gruis	....	2	22 1 56	3·80	47 26 43 S.	− 17·3
β Gruis	....	2	22 36 42	3·60	47 24 28 S.	− 18·7
α Piscis Aust.	*Fomalhaut*	1	22 52 7	3·32	30 9 8 S.	− 19·0
α Pegasi	*Markab*	2	22 59 47	2·98	14 40 2 N.	+ 19·3

LOGARITHMS OF NUMBERS

No. 1 to 100 — Log. 0·000000 to 2·000000

No.	Log.	No.	Log.	No.	Log.	No.	Log.	No.	Log.
1	0·000000	21	1·322219	41	1·612784	61	1·785330	81	1·908485
2	0·301030	22	1·342423	42	1·623249	62	1·792392	82	1·913814
3	0·477121	23	1·361728	43	1·633468	63	1·799341	83	1·919078
4	0·602060	24	1·380211	44	1·643453	64	1·806180	84	1·924279
5	0·698970	25	1·397940	45	1·653213	65	1·812913	85	1·929419
6	0·778151	26	1·414973	46	1·662758	66	1·819544	86	1·934498
7	0·845098	27	1·431364	47	1·672098	67	1·826075	87	1·939519
8	0·903090	28	1·447158	48	1·681241	68	1·832509	88	1·944483
9	0·954243	29	1·462398	49	1·690196	69	1·838849	89	1·949390
10	1·000000	30	1·477121	50	1·698970	70	1·845098	90	1·954243
11	1·041393	31	1·491362	51	1·707570	71	1·851258	91	1·959041
12	1·079181	32	1·505150	52	1·716003	72	1·857332	92	1·963788
13	1·113943	33	1·518514	53	1·724276	73	1·863323	93	1·968483
14	1·146128	34	1·531479	54	1·732394	74	1·869232	94	1·973128
15	1·176091	35	1·544068	55	1·740363	75	1·875061	95	1·977724
16	1·204120	36	1·556303	56	1·748188	76	1·880814	96	1·982271
17	1·230449	37	1·568202	57	1·755875	77	1·886491	97	1·986772
18	1·255273	38	1·579784	58	1·763428	78	1·892095	98	1·991226
19	1·278754	39	1·591065	59	1·770852	79	1·897627	99	1·995635
20	1·301030	40	1·602060	60	1·778151	80	1·903090	100	2·000000

No. 1000 to 1149 — Log. 0 to 060320

No.	0	1	2	3	4	5	6	7	8	9	D.
100	000000	000434	000868	001301	001734	002166	002598	003029	003461	003891	432
101	004321	004751	005181	005609	006038	006466	006894	007321	007748	008174	428
102	008600	009026	009451	009876	010300	010724	011147	011570	011993	012415	424
103	012837	013259	013680	014100	014521	014940	015360	015779	016197	016616	420
104	017033	017451	017868	018284	018700	019116	019532	019947	020361	020775	416
105	021189	021603	022016	022428	022841	023252	023664	024075	024486	024896	412
106	025306	025715	026125	026533	026942	027350	027757	028164	028571	028978	408
107	029384	029789	030195	030600	031004	031408	031812	032216	032619	033021	404
108	033424	033826	034227	034628	035029	035430	035830	036230	036629	037028	400
109	037426	037825	038223	038620	039017	039414	039811	040207	040602	040998	397
110	041393	041787	042182	042576	042969	043362	043755	044148	044540	044932	393
111	045323	045714	046105	046495	046885	047275	047664	048053	048442	048830	389
112	049218	049606	049993	050380	050766	051153	051538	051924	052309	052694	386
113	053078	053463	053846	054230	054613	054996	055378	055760	056142	056524	383
114	056905	057286	057666	058046	058426	058805	059185	059563	059942	060320	379
No.	0	1	2	3	4	5	6	7	8	9	D.

D.	1	2	3	4	5	6	7	8	9	D.	1	2	3	4	5	6	7	8	9
378	38	76	113	151	189	227	265	302	340	408	41	82	122	163	204	245	286	326	367
380	38	76	114	152	190	228	266	304	342	410	41	82	123	164	205	246	287	328	369
382	38	76	115	153	191	229	267	306	344	412	41	82	124	165	206	247	288	330	371
384	38	77	115	154	192	230	269	307	346	414	41	83	124	166	207	248	290	331	373
386	39	77	116	154	193	232	270	309	347	416	42	83	125	166	208	250	291	333	374
388	39	78	116	155	194	233	272	310	349	418	42	84	125	167	209	251	293	334	376
390	39	78	117	156	195	234	273	312	351	420	42	84	126	168	210	252	294	336	378
392	39	78	118	157	196	235	274	314	353	422	42	84	127	169	211	253	295	338	380
394	39	79	118	158	197	236	276	315	355	424	42	85	127	170	212	254	297	339	382
396	40	79	119	158	198	238	277	317	356	426	43	85	128	170	213	256	298	341	383
398	40	80	119	159	199	239	279	318	358	428	43	86	128	171	214	257	300	342	385
400	40	80	120	160	200	240	280	320	360	430	43	86	129	172	215	258	301	344	387
402	40	80	121	161	201	241	281	322	362	432	43	86	130	173	216	259	302	346	389
404	40	81	121	162	202	242	283	323	364	434	43	87	130	174	217	260	304	347	391
406	41	81	122	162	203	244	284	325	365										

LOGARITHMS OF NUMBERS

No. 1150 to 1499 Log. 060698 to 175802

No.	0	1	2	3	4	5	6	7	8	9	D.
115	060698	061075	061452	061829	062206	062582	062958	063333	063709	064083	376
116	064458	064832	065206	065580	065953	066326	066699	067071	067443	067815	373
117	068186	068557	068927	069298	069668	070038	070407	070776	071145	071514	370
118	071882	072250	072617	072985	073352	073718	074085	074451	074816	075182	366
119	075547	075912	076276	076640	077004	077368	077731	078094	078457	078819	363
120	079181	079543	079904	080266	080626	080987	081347	081707	082067	082426	360
121	082785	083144	083503	083861	084219	084576	084934	085291	085647	086004	357
122	086360	086716	087071	087426	087781	088136	088490	088845	089198	089552	355
123	089905	090258	090611	090963	091315	091667	092018	092370	092721	093071	352
124	093422	093772	094122	094471	094820	095169	095518	095866	096215	096562	349
125	096910	097257	097604	097951	098298	098644	098990	099335	099681	100026	346
126	100371	100715	101059	101403	101747	102091	102434	102777	103119	103462	343
127	103804	104146	104487	104828	105169	105510	105851	106191	106531	106871	341
128	107210	107549	107888	108227	108565	108903	109241	109579	109916	110253	338
129	110590	110926	111263	111599	111934	112270	112605	112940	113275	113609	335
130	113943	114277	114611	114944	115278	115611	115943	116276	116608	116940	333
131	117271	117603	117934	118265	118595	118926	119256	119586	119915	120245	330
132	120574	120903	121231	121560	121888	122216	122544	122871	123198	123525	328
133	123852	124178	124504	124830	125156	125481	125806	126131	126456	126781	325
134	127105	127429	127753	128076	128399	128722	129045	129368	129690	130012	323
135	130334	130655	130977	131298	131619	131939	132260	132580	132900	133219	321
136	133539	133858	134177	134496	134814	135133	135451	135769	136086	136403	318
137	136721	137037	137354	137671	137987	138303	138618	138934	139249	139564	316
138	139879	140194	140508	140822	141136	141450	141763	142076	142389	142702	314
139	143015	143327	143639	143951	144263	144574	144885	145196	145507	145818	311
140	146128	146438	146748	147058	147367	147676	147985	148294	148603	148911	309
141	149219	149527	149835	150142	150449	150756	151063	151370	151676	151982	307
142	152288	152594	152900	153205	153510	153815	154120	154424	154728	155032	305
143	155336	155640	155943	156246	156549	156852	157154	157457	157759	158061	303
144	158362	158664	158965	159266	159567	159868	160168	160469	160769	161068	301
145	161368	161667	161967	162266	162564	162863	163161	163460	163758	164055	299
146	164353	164650	164947	165244	165541	165838	166134	166430	166726	167022	297
147	167317	167613	167908	168203	168497	168792	169086	169380	169674	169968	295
148	170262	170555	170848	171141	171434	171726	172019	172311	172603	172895	293
149	173186	173478	173769	174060	174351	174641	174932	175222	175512	175802	291
No.	0	1	2	3	4	5	6	7	8	9	D.

D.	1	2	3	4	5	6	7	8	9	D.	1	2	3	4	5	6	7	8	9
290	29	58	87	116	145	174	203	232	261	334	33	67	100	134	167	200	234	267	301
292	29	58	88	117	146	175	204	234	263	336	34	67	101	134	168	202	235	269	302
294	29	59	88	118	147	176	206	235	265	338	34	68	101	135	169	203	237	270	304
296	30	59	89	118	148	178	207	237	266	340	34	68	102	136	170	204	238	272	306
298	30	60	89	119	149	179	209	238	268	342	34	68	103	137	171	205	239	274	308
300	30	60	90	120	150	180	210	240	270	344	34	69	103	138	172	206	241	275	310
302	30	60	91	121	151	181	211	242	272	346	35	69	104	138	173	208	242	277	311
304	30	61	91	122	152	182	213	243	274	348	35	70	104	139	174	209	244	278	313
306	31	61	92	122	153	184	214	245	275	350	35	70	105	140	175	210	245	280	315
308	31	62	92	123	154	185	216	246	277	352	35	70	106	141	176	211	246	282	317
310	31	62	93	124	155	186	217	248	279	354	35	71	106	142	177	212	248	283	319
312	31	62	94	125	156	187	218	250	281	356	36	71	107	142	178	214	249	285	320
314	31	63	94	126	157	188	220	251	283	358	36	72	107	143	179	215	251	286	322
316	32	63	95	126	158	190	221	253	284	360	36	72	108	144	180	216	252	288	324
318	32	64	95	127	159	191	223	254	286	362	36	72	109	145	181	217	253	290	326
320	32	64	96	128	160	192	224	256	288	364	36	73	109	146	182	218	255	291	328
322	32	64	97	129	161	193	225	258	290	366	37	73	110	146	183	220	256	293	329
324	32	65	97	130	162	194	227	259	292	368	37	74	110	147	184	221	258	294	331
326	33	65	98	130	163	196	228	261	293	370	37	74	111	148	185	222	259	296	333
328	33	66	98	131	164	197	230	262	295	372	37	74	112	149	186	223	260	298	335
330	33	66	99	132	165	198	231	264	297	374	37	75	112	150	187	224	262	299	337
332	33	66	100	133	166	199	232	266	299	376	38	75	113	150	188	226	263	301	338

LOGARITHMS OF NUMBERS

No. 1500 to 1899 — **Log. 176091 to 278525**

No.	0	1	2	3	4	5	6	7	8	9	D.
150	176091	176381	176670	176959	177248	177536	177825	178113	178401	178689	289
151	178977	179264	179552	179839	180126	180413	180699	180986	181272	181558	287
152	181844	182129	182415	182700	182985	183270	183555	183839	184123	184407	285
153	184691	184975	185259	185542	185825	186108	186391	186674	186956	187239	283
154	187521	187803	188084	188366	188647	188928	189209	189490	189771	190051	281
155	190332	190612	190892	191171	191451	191730	192010	192289	192567	192846	279
156	193125	193403	193681	193959	194237	194514	194792	195069	195346	195623	278
157	195900	196176	196453	196729	197005	197281	197556	197832	198107	198382	276
158	198657	198932	199206	199481	199755	200029	200303	200577	200850	201124	274
159	201397	201670	201943	202216	202488	202761	203033	203305	203577	203848	272
160	204120	204391	204663	204934	205204	205475	205746	206016	206286	206556	271
161	206826	207096	207365	207634	207904	208173	208441	208710	208979	209247	269
162	209515	209783	210051	210319	210586	210853	211121	211388	211654	211921	267
163	212188	212454	212720	212986	213252	213518	213783	214049	214314	214579	266
164	214844	215109	215373	215638	215902	216166	216430	216694	216957	217221	264
165	217484	217747	218010	218273	218536	218798	219060	219323	219585	219846	262
166	220108	220370	220631	220892	221153	221414	221675	221936	222196	222456	261
167	222716	222976	223236	223496	223755	224015	224274	224533	224792	225051	259
168	225309	225568	225826	226084	226342	226600	226858	227115	227372	227630	258
169	227887	228144	228400	228657	228913	229170	229426	229682	229938	230193	256
170	230449	230704	230960	231215	231470	231724	231979	232234	232488	232742	255
171	232996	233250	233504	233757	234011	234264	234517	234770	235023	235276	253
172	235528	235781	236033	236285	236537	236789	237041	237292	237544	237795	252
173	238046	238297	238548	238799	239049	239299	239550	239800	240050	240300	250
174	240549	240799	241048	241297	241546	241795	242044	242293	242541	242790	249
175	243038	243286	243534	243782	244030	244277	244525	244772	245019	245266	248
176	245513	245759	246006	246252	246499	246745	246991	247237	247482	247728	246
177	247973	248219	248464	248709	248954	249198	249443	249687	249932	250176	245
178	250420	250664	250908	251151	251395	251638	251881	252125	252368	252610	243
179	252853	253096	253338	253580	253822	254064	254306	254548	254790	255031	242
180	255273	255514	255755	255996	256237	256477	256718	256958	257198	257439	241
181	257679	257918	258158	258398	258637	258877	259116	259355	259594	259833	239
182	260071	260310	260548	260787	261025	261263	261501	261739	261976	262214	238
183	262451	262688	262925	263162	263399	263636	263873	264109	264346	264582	237
184	264818	265054	265290	265525	265761	265996	266232	266467	266702	266937	235
185	267172	267406	267641	267875	268110	268344	268578	268812	269046	269279	234
186	269513	269746	269980	270213	270446	270679	270912	271144	271377	271609	233
187	271842	272074	272306	272538	272770	273001	273233	273464	273696	273927	232
188	274158	274389	274620	274850	275081	275311	275542	275772	276002	276232	230
189	276462	276692	276921	277151	277380	277609	277838	278067	278296	278525	229
No	0	1	2	3	4	5	6	7	8	9	D.

D.	1	2	3	4	5	6	7	8	9	D.	1	2	3	4	5	6	7	8	9
228	23	46	68	91	114	137	160	182	205	260	26	52	78	104	130	156	182	208	234
230	23	46	69	92	115	138	161	184	207	262	26	52	79	105	131	157	183	210	236
232	23	46	70	93	116	139	162	186	209	264	26	53	79	106	132	158	185	211	238
234	23	47	70	94	117	140	164	187	211	266	27	53	80	106	133	160	186	213	239
236	24	47	71	94	118	142	165	189	212	268	27	54	80	107	134	161	188	214	241
238	24	48	71	95	119	143	167	190	214	270	27	54	81	108	135	162	189	216	243
240	24	48	72	96	120	144	168	192	216	272	27	54	82	109	136	163	190	218	245
242	24	48	73	97	121	145	169	194	218	274	27	55	82	110	137	164	192	219	247
244	24	49	73	98	122	146	171	195	220	276	28	55	83	110	138	166	193	221	248
246	25	49	74	98	123	148	172	197	221	278	28	56	83	111	139	167	195	222	250
248	25	50	74	99	124	149	174	198	223	280	28	56	84	112	140	168	196	224	252
250	25	50	75	100	125	150	175	200	225	282	28	56	85	113	141	169	197	226	254
252	25	50	76	101	126	151	176	202	227	284	28	57	85	114	142	170	199	227	256
254	25	51	76	102	127	152	178	203	229	286	29	57	86	114	143	172	200	229	257
256	26	51	77	102	128	154	179	205	230	288	29	58	86	115	144	173	202	230	259
258	26	52	77	103	129	155	181	206	232	290	29	58	87	116	145	174	203	232	161

LOGARITHMS OF NUMBERS

No. 1900 to 2349 — Log. 278754 to 370883

No.	0	1	2	3	4	5	6	7	8	9	D.
190	278754	278982	279211	279439	279667	279895	280123	280351	280578	280806	228
191	281033	281261	281488	281715	281942	282169	282396	282622	282849	283075	227
192	283301	283527	283753	283979	284205	284431	284656	284882	285107	285332	226
193	285557	285782	286007	286232	286456	286681	286905	287130	287354	287578	225
194	287802	288026	288249	288473	288696	288920	289143	289366	289589	289812	223
195	290035	290257	290480	290702	290925	291147	291369	291591	291813	292034	222
196	292256	292478	292699	292920	293141	293363	293584	293804	294025	294246	221
197	294466	294687	294907	295127	295347	295567	295787	296007	296226	296446	220
198	296665	296884	297104	297323	297542	297761	297979	298198	298416	298635	219
199	298853	299071	299289	299507	299725	299943	300161	300378	300595	300813	218
200	301030	301247	301464	301681	301898	302114	302331	302547	302764	302980	217
201	303196	303412	303628	303844	304059	304275	304491	304706	304921	305136	216
202	305351	305566	305781	305996	306211	306425	306639	306854	307068	307282	215
203	307496	307710	307924	308137	308351	308564	308778	308991	309204	309417	213
204	309630	309843	310056	310268	310481	310693	310906	311118	311330	311542	212
205	311754	311966	312177	312389	312600	312812	313023	313234	313445	313656	211
206	313867	314078	314289	314499	314710	314920	315130	315340	315551	315760	210
207	315970	316180	316390	316599	316809	317018	317227	317436	317646	317854	209
208	318063	318272	318481	318689	318898	319106	319314	319522	319730	319938	208
209	320146	320354	320562	320769	320977	321184	321391	321598	321805	322012	207
210	322219	322426	322633	322839	323046	323252	323458	323665	323871	324077	206
211	324282	324488	324694	324899	325105	325310	325516	325721	325926	326131	205
212	326336	326541	326745	326950	327155	327359	327563	327767	327972	328176	204
213	328380	328583	328787	328991	329194	329398	329601	329805	330008	330211	203
214	330414	330617	330819	331022	331225	331427	331630	331832	332034	332236	202
215	332438	332640	332842	333044	333246	333447	333649	333850	334051	334253	202
216	334454	334655	334856	335057	335257	335458	335658	335859	336059	336260	201
217	336460	336660	336860	337060	337260	337459	337659	337858	338058	338257	200
218	338456	338656	338855	339054	339253	339451	339650	339849	340047	340246	199
219	340444	340642	340841	341039	341237	341435	341632	341830	342028	342225	198
220	342423	342620	342817	343014	343212	343409	343606	343802	343999	344196	197
221	344392	344589	344785	344981	345178	345374	345570	345766	345962	346157	196
222	346353	346549	346744	346939	347135	347330	347525	347720	347915	348110	195
223	348305	348500	348694	348889	349083	349278	349472	349666	349860	350054	194
224	350248	350442	350636	350829	351023	351216	351410	351603	351796	351989	193
225	352183	352375	352568	352761	352954	353147	353339	353532	353724	353916	193
226	354108	354301	354493	354685	354876	355068	355260	355452	355643	355834	192
227	356026	356217	356408	356599	356790	356981	357172	357363	357554	357744	191
228	357935	358125	358316	358506	358696	358886	359076	359266	359456	359646	190
229	359835	360025	360215	360404	360593	360783	360972	361161	361350	361539	189
230	361728	361917	362105	362294	362482	362671	362859	363048	363236	363424	188
231	363612	363800	363988	364176	364363	364551	364739	364926	365113	365301	188
232	365488	365675	365862	366049	366236	366423	366610	366796	366983	367169	187
233	367356	367542	367729	367915	368101	368287	368473	368659	368845	369030	186
234	369216	369401	369587	369772	369958	370143	370328	370513	370698	370883	185
No.	0	1	2	3	4	5	6	7	8	9	D.

D.	1	2	3	4	5	6	7	8	9
184	18	37	55	74	92	110	129	147	166
186	19	37	56	74	93	112	130	149	167
188	19	38	56	75	94	113	132	150	169
190	19	38	57	76	95	114	133	152	171
192	19	38	58	77	96	115	134	154	173
194	19	39	58	78	97	116	136	155	175
196	20	39	59	78	98	118	137	157	176
198	20	40	59	79	99	119	139	158	178
200	20	40	60	80	100	120	140	160	180
202	20	40	61	81	101	121	141	162	182
204	20	41	61	82	102	122	143	163	184
206	21	41	62	82	103	124	144	165	185

D.	1	2	3	4	5	6	7	8	9
208	21	42	62	83	104	125	146	166	187
210	21	42	63	84	105	126	147	168	189
212	21	42	64	85	106	127	148	170	191
214	21	43	64	86	107	128	150	171	193
216	22	43	65	86	108	130	151	173	194
218	22	44	65	87	109	131	153	174	196
220	22	44	66	88	110	132	154	176	198
222	22	44	67	89	111	133	155	178	200
224	22	45	67	90	112	134	157	179	202
226	23	45	68	90	113	136	158	181	203
228	23	46	68	91	114	137	160	182	205

LOGARITHMS OF NUMBERS

No. 2350 to 2849 Log. 371068 to 454692

No.	0	1	2	3	4	5	6	7	8	9	D.
235	371068	371253	371437	371622	371806	371991	372175	372360	372544	372728	184
236	372912	373096	373280	373464	373647	373831	374015	374198	374382	374565	184
237	374748	374932	375115	375298	375481	375664	375846	376029	376212	376394	183
238	376577	376759	376942	377124	377306	377488	377670	377852	378034	378216	182
239	378398	378580	378761	378943	379124	379306	379487	379668	379849	380030	181
240	380211	380392	380573	380754	380934	381115	381296	381476	381656	381837	181
241	382017	382197	382377	382557	382737	382917	383097	383277	383456	383636	180
242	383815	383995	384174	384353	384533	384712	384891	385070	385249	385428	179
243	385606	385785	385964	386142	386321	386499	386677	386856	387034	387212	178
244	387390	387568	387746	387923	388101	388279	388456	388634	388811	388989	178
245	389166	389343	389520	389698	389875	390051	390228	390405	390582	390759	177
246	390935	391112	391288	391464	391641	391817	391993	392169	392345	392521	176
247	392697	392873	393048	393224	393400	393575	393751	393926	394101	394277	176
248	394452	394627	394802	394977	395152	395326	395501	395676	395850	396025	175
249	396199	396374	396548	396722	396896	397071	397245	397419	397592	397766	174
250	397940	398114	398287	398461	398634	398808	398981	399154	399328	399501	173
251	399674	399847	400020	400192	400365	400538	400711	400883	401056	401228	173
252	401401	401573	401745	401917	402089	402261	402433	402605	402777	402949	172
253	403121	403292	403464	403635	403807	403978	404149	404320	404492	404663	171
254	404834	405005	405176	405346	405517	405688	405858	406029	406199	406370	171
255	406540	406710	406881	407051	407221	407391	407561	407731	407901	408070	170
256	408240	408410	408579	408749	408918	409087	409257	409426	409595	409764	169
257	409933	410102	410271	410440	410609	410777	410946	411114	411283	411451	169
258	411620	411788	411956	412124	412293	412461	412629	412796	412964	413132	168
259	413300	413467	413635	413803	413970	414137	414305	414472	414639	414806	167
260	414973	415140	415307	415474	415641	415808	415974	416141	416308	416474	167
261	416641	416807	416973	417139	417306	417472	417638	417804	417970	418135	166
262	418301	418467	418633	418798	418964	419129	419295	419460	419625	419791	165
263	419956	420121	420286	420451	420616	420781	420945	421110	421275	421439	165
264	421604	421768	421933	422097	422261	422426	422590	422754	422918	423082	164
265	423246	423410	423574	423737	423901	424065	424228	424392	424555	424718	164
266	424882	425045	425208	425371	425534	425697	425860	426023	426186	426349	163
267	426511	426674	426836	426999	427161	427324	427486	427648	427811	427973	162
268	428135	428297	428459	428621	428783	428944	429106	429268	429429	429591	162
269	429752	429914	430075	430236	430398	430559	430720	430881	431042	431203	161
270	431364	431525	431685	431846	432007	432167	432328	432488	432649	432809	161
271	432969	433130	433290	433450	433610	433770	433930	434090	434249	434409	160
272	434569	434729	434888	435048	435207	435367	435526	435685	435844	436004	159
273	436163	436322	436481	436640	436799	436957	437116	437275	437433	437592	159
274	437751	437909	438067	438226	438384	438542	438701	438859	439017	439175	158
275	439333	439491	439648	439806	439964	440122	440279	440437	440594	440752	158
276	440909	441066	441224	441381	441538	441695	441852	442009	442166	442323	157
277	442480	442637	442793	442950	443106	443263	443419	443576	443732	443889	157
278	444045	444201	444357	444513	444669	444825	444981	445137	445293	445449	156
279	445604	445760	445915	446071	446226	446382	446537	446692	446848	447003	155
280	447158	447313	447468	447623	447778	447933	448088	448242	448397	448552	155
281	448706	448861	449015	449170	449324	449478	449633	449787	449941	450095	154
282	450249	450403	450557	450711	450865	451018	451172	451326	451479	451633	154
283	451786	451940	452093	452247	452400	452553	452706	452859	453012	453165	153
284	453318	453471	453624	453777	453930	454082	454235	454387	454540	454692	153
No.	0	1	2	3	4	5	6	7	8	9	D.

D.	1	2	3	4	5	6	7	8	9	D.	1	2	3	4	5	6	7	8	9
152	15	30	46	61	76	91	106	122	137	170	17	34	51	68	85	102	119	136	153
154	15	31	46	62	77	92	108	123	139	172	17	34	52	69	86	103	120	138	155
156	16	31	47	62	78	94	109	125	140	174	17	35	52	70	87	104	122	139	157
158	16	32	47	63	79	95	111	126	142	176	18	35	53	70	88	106	123	141	158
160	16	32	48	64	80	96	112	128	144	178	18	36	53	71	89	107	125	142	160
162	16	32	49	65	81	97	113	130	146	180	18	36	54	72	90	108	126	144	162
164	16	33	49	66	82	98	115	131	148	182	18	36	55	73	91	109	127	146	164
166	17	33	50	66	83	100	116	133	149	184	18	37	55	74	92	110	129	147	166
168	17	34	50	67	84	101	118	134	151										

LOGARITHMS OF NUMBERS

No. 2850 to 3349 — Log. 454845 to 524915

No.	0	1	2	3	4	5	6	7	8	9	D
285	454845	454997	455150	455302	455454	455606	455758	455910	456062	456214	152
286	456366	456518	456670	456821	456973	457125	457276	457428	457579	457731	152
287	457882	458033	458184	458336	458487	458638	458789	458940	459091	459242	151
288	459392	459543	459694	459845	459995	460146	460296	460447	460597	460748	151
289	460898	461048	461198	461348	461499	461649	461799	461948	462098	462248	150
290	462398	462548	462697	462847	462997	463146	463296	463445	463594	463744	150
291	463893	464042	464191	464340	464490	464639	464788	464936	465085	465234	149
292	465383	465532	465680	465829	465977	466126	466274	466423	466571	466719	149
293	466868	467016	467164	467312	467460	467608	467756	467904	468052	468200	148
294	468347	468495	468643	468790	468938	469085	469233	469380	469527	469675	148
295	469822	469969	470116	470263	470410	470557	470704	470851	470998	471145	147
296	471292	471438	471585	471732	471878	472025	472171	472318	472464	472610	146
297	472756	472903	473049	473195	473341	473487	473633	473779	473925	474071	146
298	474216	474362	474508	474653	474799	474944	475090	475235	475381	475526	146
299	475671	475816	475962	476107	476252	476397	476542	476687	476832	476976	145
300	477121	477266	477411	477555	477700	477844	477989	478133	478278	478422	145
301	478566	478711	478855	478999	479143	479287	479431	479575	479719	479863	144
302	480007	480151	480294	480438	480582	480725	480869	481012	481156	481299	144
303	481443	481586	481729	481872	482016	482159	482302	482445	482588	482731	143
304	482874	483016	483159	483302	483445	483587	483730	483872	484015	484157	143
305	484300	484442	484585	484727	484869	485011	485153	485295	485437	485579	142
306	485721	485863	486005	486147	486289	486430	486572	486714	486855	486997	142
307	487138	487280	487421	487563	487704	487845	487986	488127	488269	488410	141
308	488551	488692	488833	488974	489114	489255	489396	489537	489677	489818	141
309	489958	490099	490239	490380	490520	490661	490801	490941	491081	491222	140
310	491362	491502	491642	491782	491922	492062	492201	492341	492481	492621	140
311	492760	492900	493040	493179	493319	493458	493597	493737	493876	494015	139
312	494155	494294	494433	494572	494711	494850	494989	495128	495267	495406	139
313	495544	495683	495822	495960	496099	496238	496376	496515	496653	496791	139
314	496930	497068	497206	497344	497483	497621	497759	497897	498035	498173	138
315	498311	498448	498586	498724	498862	498999	499137	499275	499412	499550	138
316	499687	499824	499962	500099	500236	500374	500511	500648	500785	500922	137
317	501059	501196	501333	501470	501607	501744	501880	502017	502154	502291	137
318	502427	502564	502700	502837	502973	503109	503246	503382	503518	503655	136
319	503791	503927	504063	504199	504335	504471	504607	504743	504878	505014	136
320	505150	505286	505421	505557	505693	505828	505964	506099	506234	506370	136
321	506505	506640	506776	506911	507046	507181	507316	507451	507586	507721	135
322	507856	507991	508126	508260	508395	508530	508664	508799	508934	509068	135
323	509203	509337	509471	509606	509740	509874	510009	510143	510277	510411	134
324	510545	510679	510813	510947	511081	511215	511349	511482	511616	511750	134
325	511883	512017	512151	512284	512418	512551	512684	512818	512951	513084	133
326	513218	513351	513484	513617	513750	513883	514016	514149	514282	514415	133
327	514548	514681	514813	514946	515079	515211	515344	515476	515609	515741	133
328	515874	516006	516139	516271	516403	516535	516668	516800	516932	517064	132
329	517196	517328	517460	517592	517724	517855	517987	518119	518251	518382	132
330	518514	518646	518777	518909	519040	519171	519303	519434	519566	519697	131
331	519828	519959	520090	520221	520353	520484	520615	520745	520876	521007	131
332	521138	521269	521400	521530	521661	521792	521922	522053	522183	522314	131
333	522444	522575	522705	522835	522966	523096	523226	523356	523486	523616	130
334	523746	523876	524006	524136	524266	524396	524526	524656	524785	524915	130
No.	0	1	2	3	4	5	6	7	8	9	D.

D.	1	2	3	4	5	6	7	8	9
130	13	26	39	52	65	78	91	104	117
132	13	26	40	53	66	79	92	106	119
134	13	27	40	54	67	80	94	107	121
136	14	27	41	54	68	82	95	109	122
138	14	28	41	55	69	83	97	110	124
140	14	28	42	56	70	84	98	112	126

D.	1	2	3	4	5	6	7	8	9
142	14	28	43	57	71	85	99	114	128
144	14	29	43	58	72	86	101	115	130
146	15	29	44	58	73	88	102	117	131
148	15	30	44	59	74	89	104	118	133
150	15	30	45	60	75	90	105	120	135
152	15	30	46	61	76	91	106	122	137

LOGARITHMS OF NUMBERS

No. 3350 to 3899 — Log. 525045 to 590953

No.	0	1	2	3	4	5	6	7	8	9	D.
335	525045	525174	525304	525434	525563	525693	525822	525951	526081	526210	129
336	526339	526469	526598	526727	526856	526985	527114	527243	527372	527501	129
337	527630	527759	527888	528016	528145	528274	528402	528531	528660	528788	129
338	528917	529045	529174	529302	529430	529559	529687	529815	529943	530072	128
339	530200	530328	530456	530584	530712	530840	530968	531096	531223	531351	128
340	531479	531607	531734	531862	531990	532117	532245	532372	532500	532627	128
341	532754	532882	533009	533136	533264	533391	533518	533645	533772	533899	127
342	534026	534153	534280	534407	534534	534661	534787	534914	535041	535167	127
343	535294	535421	535547	535674	535800	535927	536053	536180	536306	536432	126
344	536558	536685	536811	536937	537063	537189	537315	537441	537567	537693	126
345	537819	537945	538071	538197	538322	538448	538574	538699	538825	538951	126
346	539076	539202	539327	539452	539578	539703	539829	539954	540079	540204	125
347	540329	540455	540580	540705	540830	540955	541080	541205	541330	541454	125
348	541579	541704	541829	541953	542078	542203	542327	542452	542576	542701	125
349	542825	542950	543074	543199	543323	543447	543571	543696	543820	543944	124
350	544068	544192	544316	544440	544564	544688	544812	544936	545060	545183	124
351	545307	545431	545555	545678	545802	545925	546049	546172	546296	546419	124
352	546543	546666	546789	546913	547036	547159	547282	547405	547529	547652	123
353	547775	547898	548021	548144	548267	548389	548512	548635	548758	548881	123
354	549003	549126	549249	549371	549494	549616	549739	549861	549984	550106	123
355	550228	550351	550473	550595	550717	550840	550962	551084	551206	551328	122
356	551450	551572	551694	551816	551938	552060	552181	552303	552425	552547	122
357	552668	552790	552911	553033	553155	553276	553398	553519	553640	553762	121
358	553883	554004	554126	554247	554368	554489	554610	554731	554852	554973	121
359	555094	555215	555336	555457	555578	555699	555820	555940	556061	556182	121
360	556303	556423	556544	556664	556785	556905	557026	557146	557267	557387	120
361	557507	557627	557748	557868	557988	558108	558228	558349	558469	558589	120
362	558709	558829	558948	559068	559188	559308	559428	559548	559667	559787	120
363	559907	560026	560146	560265	560385	560504	560624	560743	560863	560982	119
364	561101	561221	561340	561459	561578	561698	561817	561936	562055	562174	119
365	562293	562412	562531	562650	562769	562887	563006	563125	563244	563362	119
366	563481	563600	563718	563837	563955	564074	564192	564311	564429	564548	119
367	564666	564784	564903	565021	565139	565257	565376	565494	565612	565730	118
368	565848	565966	566084	566202	566320	566437	566555	566673	566791	566909	118
369	567026	567144	567262	567379	567497	567614	567732	567849	567967	568084	118
370	568202	568319	568436	568554	568671	568788	568905	569023	569140	569257	117
371	569374	569491	569608	569725	569842	569959	570076	570193	570309	570426	117
372	570543	570660	570776	570893	571010	571126	571243	571359	571476	571592	117
373	571709	571825	571942	572058	572174	572291	572407	572523	572639	572755	116
374	572872	572988	573104	573220	573336	573452	573568	573684	573800	573915	116
375	574031	574147	574263	574379	574494	574610	574726	574841	574957	575072	116
376	575188	575303	575419	575534	575650	575765	575880	575996	576111	576226	116
377	576341	576457	576572	576687	576802	576917	577032	577147	577262	577377	115
378	577492	577607	577722	577836	577951	578066	578181	578295	578410	578525	115
379	578639	578754	578868	578983	579097	579212	579326	579441	579555	579669	114
380	579784	579898	580012	580126	580241	580355	580469	580583	580697	580811	114
381	580925	581039	581153	581267	581381	581495	581608	581722	581836	581950	114
382	582063	582177	582291	582404	582518	582631	582745	582858	582972	583085	114
383	583199	583312	583426	583539	583652	583765	583879	583992	584105	584218	113
384	584331	584444	584557	584670	584783	584896	585009	585122	585235	585348	113
385	585461	585574	585686	585799	585912	586024	586137	586250	586362	586475	113
386	586587	586700	586812	586925	587037	587149	587262	587374	587486	587599	112
387	587711	587823	587935	588047	588160	588272	588384	588496	588608	588720	112
388	588832	588944	589056	589167	589279	589391	589503	589615	589726	589838	112
389	589950	590061	590173	590284	590396	590507	590619	590730	590842	590953	112
No.	0	1	2	3	4	5	6	7	8	9	D.

D.	1	2	3	4	5	6	7	8	9	D.	1	2	3	4	5	6	7	8	9
112	11	22	34	45	56	67	78	90	101	122	12	24	37	49	61	73	85	98	110
114	11	23	34	46	57	68	80	91	103	124	12	25	37	50	62	74	87	99	112
116	12	23	35	46	58	70	81	93	104	126	13	25	38	50	63	76	88	101	113
118	12	24	35	47	59	71	83	94	106	128	13	26	38	51	64	77	90	102	115
120	12	24	36	48	60	72	84	96	108	130	13	26	39	52	65	78	91	104	117

LOGARITHMS OF NUMBERS

No. 3900 to 4449 Log. 591065 to 648262

No.	0	1	2	3	4	5	6	7	8	9	D.
390	591065	591176	591287	591399	591510	591621	591732	591843	591955	592066	111
391	592177	592288	592399	592510	592621	592732	592843	592954	593064	593175	111
392	593286	593397	593508	593618	593729	593840	593950	594061	594171	594282	111
393	594393	594503	594614	594724	594834	594945	595055	595165	595276	595386	110
394	595496	595606	595717	595827	595937	596047	596157	596267	596377	596487	110
395	596597	596707	596817	596927	597037	597146	597256	597366	597476	597586	110
396	597695	597805	597914	598024	598134	598243	598353	598462	598572	598681	110
397	598791	598900	599009	599119	599228	599337	599446	599556	599665	599774	109
398	599883	599992	600101	600210	600319	600428	600537	600646	600755	600864	109
399	600973	601082	601191	601299	601408	601517	601625	601734	601843	601951	109
400	602060	602169	602277	602386	602494	602603	602711	602819	602928	603036	108
401	603144	603253	603361	603469	603577	603686	603794	603902	604010	604118	108
402	604226	604334	604442	604550	604658	604766	604874	604982	605089	605197	108
403	605305	605413	605521	605628	605736	605844	605951	606059	606166	606274	108
404	606381	606489	606596	606704	606811	606919	607026	607133	607241	607348	107
405	607455	607562	607669	607777	607884	607991	608098	608205	608312	608419	107
406	608526	608633	608740	608847	608954	609061	609167	609274	609381	609488	107
407	609594	609701	609808	609914	610021	610128	610234	610341	610447	610554	107
408	610660	610767	610873	610979	611086	611192	611298	611405	611511	611617	106
409	611723	611829	611936	612042	612148	612254	612360	612466	612572	612678	106
410	612784	612890	612996	613102	613207	613313	613419	613525	613630	613736	106
411	613842	613947	614053	614159	614264	614370	614475	614581	614686	614792	106
412	614897	615003	615108	615213	615319	615424	615529	615634	615740	615845	105
413	615950	616055	616160	616265	616370	616476	616581	616686	616790	616895	105
414	617000	617105	617210	617315	617420	617525	617629	617734	617839	617943	105
415	618048	618153	618257	618362	618466	618571	618676	618780	618884	618989	105
416	619093	619198	619302	619406	619511	619615	619719	619824	619928	620032	104
417	620136	620240	620344	620448	620552	620656	620760	620864	620968	621072	104
418	621176	621280	621384	621488	621592	621695	621799	621903	622007	622110	104
419	622214	622318	622421	622525	622628	622732	622835	622939	623042	623146	104
420	623249	623353	623456	623559	623663	623766	623869	623973	624076	624179	103
421	624282	624385	624488	624591	624695	624798	624901	625004	625107	625210	103
422	625312	625415	625518	625621	625724	625827	625929	626032	626135	626238	103
423	626340	626443	626546	626648	626751	626853	626956	627058	627161	627263	103
424	627366	627468	627571	627673	627775	627878	627980	628082	628185	628287	102
425	628389	628491	628593	628695	628797	628900	629002	629104	629206	629308	102
426	629410	629512	629613	629715	629817	629919	630021	630123	630224	630326	102
427	630428	630530	630631	630733	630835	630936	631038	631139	631241	631342	102
428	631444	631545	631647	631748	631849	631951	632052	632153	632255	632356	101
429	632457	632559	632660	632761	632862	632963	633064	633165	633266	633367	101
430	633468	633569	633670	633771	633872	633973	634074	634175	634276	634376	101
431	634477	634578	634679	634779	634880	634981	635081	635182	635283	635383	101
432	635484	635584	635685	635785	635886	635986	636087	636187	636287	636388	100
433	636488	636588	636688	636789	636889	636989	637089	637189	637290	637390	100
434	637490	637590	637690	637790	637890	637990	638090	638190	638290	638389	100
435	638489	638589	638689	638789	638888	638988	639088	639188	639287	639387	100
436	639486	639586	639686	639785	639885	639984	640084	640183	640283	640382	99
437	640481	640581	640680	640779	640879	640978	641077	641177	641276	641375	99
438	641474	641573	641672	641771	641871	641970	642069	642168	642267	642366	99
439	642465	642563	642662	642761	642860	642959	643058	643156	643255	643354	99
440	643453	643551	643650	643749	643847	643946	644044	644143	644242	644340	99
441	644439	644537	644636	644734	644832	644931	645029	645127	645226	645324	98
442	645422	645521	645619	645717	645815	645913	646011	646110	646208	646306	98
443	646404	646502	646600	646698	646796	646894	646992	647089	647187	647285	98
444	647383	647481	647579	647676	647774	647872	647969	648067	648165	648262	98
No.	0	1	2	3	4	5	6	7	8	9	D.

D.	1	2	3	4	5	6	7	8	9	D.	1	2	3	4	5	6	7	8	9
98	10	20	29	39	49	59	69	78	88	106	11	21	32	42	53	64	74	85	95
100	10	20	30	40	50	60	70	80	90	108	11	22	32	43	54	65	76	86	97
102	10	20	31	41	51	61	71	82	92	110	11	22	33	44	55	66	77	88	99
104	10	21	31	42	52	62	73	83	94	112	11	22	34	45	56	67	78	90	101

LOGARITHMS OF NUMBERS

No. 4450 to 4999 — Log. 648360 to 698883

No.	0	1	2	3	4	5	6	7	8	9	D.
445	648360	648458	648555	648653	648750	648848	648945	649043	649140	649237	97
446	649335	649432	649530	649627	649724	649821	649919	650016	650113	650210	97
447	650308	650405	650502	650599	650696	650793	650890	650987	651084	651181	97
448	651278	651375	651472	651569	651666	651762	651859	651956	652053	652150	97
449	652246	652343	652440	652536	652633	652730	652826	652923	653019	653116	97
450	653213	653309	653405	653502	653598	653695	653791	653888	653984	654080	96
451	654177	654273	654369	654465	654562	654658	654754	654850	654946	655042	96
452	655138	655235	655331	655427	655523	655619	655715	655810	655906	656002	96
453	656098	656194	656290	656386	656482	656577	656673	656769	656864	656960	96
454	657056	657152	657247	657343	657438	657534	657629	657725	657820	657916	96
455	658011	658107	658202	658298	658393	658488	658584	658679	658774	658870	95
456	658965	659060	659155	659250	659346	659441	659536	659631	659726	659821	95
457	659916	660011	660106	660201	660296	660391	660486	660581	660676	660771	95
458	660865	660960	661055	661150	661245	661339	661434	661529	661623	661718	95
459	661813	661907	662002	662096	662191	662286	662380	662475	662569	662663	95
460	662758	662852	662947	663041	663135	663230	663324	663418	663512	663607	94
461	663701	663795	663889	663983	664078	664172	664266	664360	664454	664548	94
462	664642	664736	664830	664924	665018	665112	665206	665299	665393	665487	94
463	665581	665675	665769	665862	665956	666050	666143	666237	666331	666424	94
464	666518	666612	666705	666799	666892	666986	667079	667173	667266	667360	94
465	667453	667546	667640	667733	667826	667920	668013	668106	668199	668293	93
466	668386	668479	668572	668665	668759	668852	668945	669038	669131	669224	93
467	669317	669410	669503	669596	669689	669782	669875	669967	670060	670153	93
468	670246	670339	670431	670524	670617	670710	670802	670895	670988	671080	93
469	671173	671265	671358	671451	671543	671636	671728	671821	671913	672005	93
470	672098	672190	672283	672375	672467	672560	672652	672744	672836	672929	92
471	673021	673113	673205	673297	673390	673482	673574	673666	673758	673850	92
472	673942	674034	674126	674218	674310	674402	674494	674586	674677	674769	92
473	674861	674953	675045	675137	675228	675320	675412	675503	675595	675687	92
474	675778	675870	675962	676053	676145	676236	676328	676419	676511	676602	92
475	676694	676785	676876	676968	677059	677151	677242	677333	677424	677516	91
476	677607	677698	677789	677881	677972	678063	678154	678245	678336	678427	91
477	678518	678609	678700	678791	678882	678973	679064	679155	679246	679337	91
478	679428	679519	679610	679700	679791	679882	679973	680063	680154	680245	91
479	680336	680426	680517	680607	680698	680789	680879	680970	681060	681151	91
480	681241	681332	681422	681513	681603	681693	681784	681874	681964	682055	90
481	682145	682235	682326	682416	682506	682596	682686	682777	682867	682957	90
482	683047	683137	683227	683317	683407	683497	683587	683677	683767	683857	90
483	683947	684037	684127	684217	684307	684396	684486	684576	684666	684756	90
484	684845	684935	685025	685114	685204	685294	685383	685473	685563	685652	90
485	685742	685831	685921	686010	686100	686189	686279	686368	686458	686547	89
486	686636	686726	686815	686904	686994	687083	687172	687261	687351	687440	89
487	687529	687618	687707	687796	687886	687975	688064	688153	688242	688331	89
488	688420	688509	688598	688687	688776	688865	688953	689042	689131	689220	89
489	689309	689398	689486	689575	689664	689753	689841	689930	690019	690107	89
490	690196	690285	690373	690462	690550	690639	690728	690816	690905	690993	89
491	691081	691170	691258	691347	691435	691524	691612	691700	691789	691877	88
492	691965	692053	692142	692230	692318	692406	692494	692583	692671	692759	88
493	692847	692935	693023	693111	693199	693287	693375	693463	693551	693639	88
494	693727	693815	693903	693991	694078	694166	694254	694342	694430	694517	88
495	694605	694693	694781	694868	694956	695044	695131	695219	695307	695394	88
496	695482	695569	695657	695744	695832	695919	696007	696094	696182	696269	87
497	696356	696444	696531	696618	696706	696793	696880	696968	697055	697142	87
498	697229	697317	697404	697491	697578	697665	697752	697839	697926	698014	87
499	698101	698188	698275	698362	698449	698535	698622	698709	698796	698883	87
No.	0	1	2	3	4	5	6	7	8	9	D.

D.	1	2	3	4	5	6	7	8	9
88	9	18	26	35	44	53	62	70	79
89	9	18	27	36	44	53	62	71	80
90	9	18	27	36	45	54	63	72	81
91	9	18	27	36	45	55	64	73	82
92	9	18	28	37	46	55	64	74	83

D.	1	2	3	4	5	6	7	8	9
93	9	19	28	37	46	56	65	74	84
94	9	19	28	38	47	56	66	75	85
95	9	19	28	38	47	57	66	76	86
96	10	19	29	38	48	58	67	77	86
97	10	19	29	39	48	58	68	78	87

LOGARITHMS OF NUMBERS

No. 5000 to 5549 Log. 698970 to 744215

No.	0	1	2	3	4	5	6	7	8	9	D.
500	698970	699057	699144	699231	699317	699404	699491	699578	699664	699751	87
501	699838	699924	700011	700098	700184	700271	700358	700444	700531	700617	87
502	700704	700790	700877	700963	701050	701136	701222	701309	701395	701482	86
503	701568	701654	701741	701827	701913	701999	702086	702172	702258	702344	86
504	702431	702517	702603	702689	702775	702861	702947	703033	703119	703205	86
505	703291	703377	703463	703549	703635	703721	703807	703893	703979	704065	86
506	704151	704236	704322	704408	704494	704579	704665	704751	704837	704922	86
507	705008	705094	705179	705265	705350	705436	705522	705607	705693	705778	86
508	705864	705949	706035	706120	706206	706291	706376	706462	706547	706632	85
509	706718	706803	706888	706974	707059	707144	707229	707315	707400	707485	85
510	707570	707655	707740	707826	707911	707996	708081	708166	708251	708336	85
511	708421	708506	708591	708676	708761	708846	708931	709015	709100	709185	85
512	709270	709355	709440	709524	709609	709694	709779	709863	709948	710033	85
513	710117	710202	710287	710371	710456	710540	710625	710710	710794	710879	85
514	710963	711048	711132	711217	711301	711385	711470	711554	711639	711723	84
515	711807	711892	711976	712060	712144	712229	712313	712397	712481	712566	84
516	712650	712734	712818	712902	712986	713070	713154	713238	713323	713407	84
517	713491	713575	713659	713742	713826	713910	713994	714078	714162	714246	84
518	714330	714414	714497	714581	714665	714749	714833	714916	715000	715084	84
519	715167	715251	715335	715418	715502	715586	715669	715753	715836	715920	84
520	716003	716087	716170	716254	716337	716421	716504	716588	716671	716754	83
521	716838	716921	717004	717088	717171	717254	717338	717421	717504	717587	83
522	717671	717754	717837	717920	718003	718086	718169	718253	718336	718419	83
523	718502	718585	718668	718751	718834	718917	719000	719083	719165	719248	83
524	719331	719414	719497	719580	719663	719745	719828	719911	719994	720077	83
525	720159	720242	720325	720407	720490	720573	720655	720738	720821	720903	83
526	720986	721068	721151	721233	721316	721398	721481	721563	721646	721728	82
527	721811	721893	721975	722058	722140	722222	722305	722387	722469	722552	82
528	722634	722716	722798	722881	722963	723045	723127	723209	723291	723374	82
529	723456	723538	723620	723702	723784	723866	723948	724030	724112	724194	82
530	724276	724358	724440	724522	724604	724685	724767	724849	724931	725013	82
531	725095	725176	725258	725340	725422	725503	725585	725667	725748	725830	82
532	725912	725993	726075	726156	726238	726320	726401	726483	726564	726646	82
533	726727	726809	726890	726972	727053	727134	727216	727297	727379	727460	81
534	727541	727623	727704	727785	727866	727948	728029	728110	728191	728273	81
535	728354	728435	728516	728597	728678	728759	728841	728922	729003	729084	81
536	729165	729246	729327	729408	729489	729570	729651	729732	729813	729893	81
537	729974	730055	730136	730217	730298	730378	730459	730540	730621	730702	81
538	730782	730863	730944	731024	731105	731186	731266	731347	731428	731508	81
539	731589	731669	731750	731830	731911	731991	732072	732152	732233	732313	81
540	732394	732474	732555	732635	732715	732796	732876	732956	733037	733117	80
541	733197	733278	733358	733438	733518	733598	733679	733759	733839	733919	80
542	733999	734079	734160	734240	734320	734400	734480	734560	734640	734720	80
543	734800	734880	734960	735040	735120	735200	735279	735359	735439	735519	80
544	735599	735679	735759	735838	735918	735998	736078	736157	736237	736317	80
545	736397	736476	736556	736635	736715	736795	736874	736954	737034	737113	80
546	737193	737272	737352	737431	737511	737590	737670	737749	737829	737908	79
547	737987	738067	738146	738225	738305	738384	738463	738543	738622	738701	79
548	738781	738860	738939	739018	739097	739177	739256	739335	739414	739493	79
549	739572	739651	739731	739810	739889	739968	740047	740126	740205	740284	79
550	740363	740442	740521	740600	740678	740757	740836	740915	740994	741073	79
551	741152	741230	741309	741388	741467	741546	741624	741703	741782	741860	79
552	741939	742018	742096	742175	742254	742332	742411	742489	742568	742647	79
553	742725	742804	742882	742961	743039	743118	743196	743275	743353	743431	78
554	743510	743588	743667	743745	743823	743902	743980	744058	744136	744215	78
No.	0	1	2	3	4	5	6	7	8	9	D.

D.	1	2	3	4	5	6	7	8	9	D.	1	2	3	4	5	6	7	8	9
78	8	16	23	31	39	47	55	62	70	83	8	17	25	33	41	50	58	66	75
79	8	16	24	32	39	47	55	63	71	84	8	17	25	34	42	50	59	67	76
80	8	16	24	32	40	48	56	64	72	85	8	17	25	34	42	51	59	68	76
81	8	16	24	32	40	49	57	65	73	86	9	17	26	34	43	52	60	69	77
82	8	16	25	33	41	49	57	66	74	87	9	17	26	35	43	52	61	70	78

LOGARITHMS OF NUMBERS

No. 5550 to 6099 Log. 744293 to 785259

No.	0	1	2	3	4	5	6	7	8	9	D.
555	744293	744371	744449	744528	744606	744684	744762	744840	744919	744997	78
556	745075	745153	745231	745309	745387	745465	745543	745621	745699	745777	78
557	745855	745933	746011	746089	746167	746245	746323	746401	746479	746556	78
558	746634	746712	746790	746868	746945	747023	747101	747179	747256	747334	78
559	747412	747489	747567	747645	747722	747800	747878	747955	748033	748110	78
560	748188	748266	748343	748421	748498	748576	748653	748731	748808	748885	77
561	748963	749040	749118	749195	749272	749350	749427	749504	749582	749659	77
562	749736	749814	749891	749968	750045	750123	750200	750277	750354	750431	77
563	750508	750586	750663	750740	750817	750894	750971	751048	751125	751202	77
564	751279	751356	751433	751510	751587	751664	751741	751818	751895	751972	77
565	752048	752125	752202	752279	752356	752433	752509	752586	752663	752740	77
566	752816	752893	752970	753047	753123	753200	753277	753353	753430	753506	77
567	753583	753660	753736	753813	753889	753966	754042	754119	754195	754272	77
568	754348	754425	754501	754578	754654	754730	754807	754883	754960	755036	76
569	755112	755189	755265	755341	755417	755494	755570	755646	755722	755799	76
570	755875	755951	756027	756103	756180	756256	756332	756408	756484	756560	76
571	756636	756712	756788	756864	756940	757016	757092	757168	757244	757320	76
572	757396	757472	757548	757624	757700	757775	757851	757927	758003	758079	76
573	758155	758230	758306	758382	758458	758533	758609	758685	758761	758836	76
574	758912	758988	759063	759139	759214	759290	759366	759441	759517	759592	76
575	759668	759743	759819	759894	759970	760045	760121	760196	760272	760347	75
576	760422	760498	760573	760649	760724	760799	760875	760950	761025	761101	75
577	761176	761251	761326	761402	761477	761552	761627	761702	761778	761853	75
578	761928	762003	762078	762153	762228	762303	762378	762453	762529	762604	75
579	762679	762754	762829	762904	762978	763053	763128	763203	763278	763353	75
580	763428	763503	763578	763653	763727	763802	763877	763952	764027	764101	75
581	764176	764251	764326	764400	764475	764550	764624	764699	764774	764848	75
582	764923	764998	765072	765147	765221	765296	765370	765445	765520	765594	75
583	765669	765743	765818	765892	765966	766041	766115	766190	766264	766338	74
584	766413	766487	766562	766636	766710	766785	766859	766933	767007	767082	74
585	767156	767230	767304	767379	767453	767527	767601	767675	767749	767823	74
586	767898	767972	768046	768120	768194	768268	768342	768416	768490	768564	74
587	768638	768712	768786	768860	768934	769008	769082	769156	769230	769303	74
588	769377	769451	769525	769599	769673	769746	769820	769894	769968	770042	74
589	770115	770189	770263	770336	770410	770484	770557	770631	770705	770778	74
590	770852	770926	770999	771073	771146	771220	771293	771367	771440	771514	74
591	771587	771661	771734	771808	771881	771955	772028	772102	772175	772248	73
592	772322	772395	772468	772542	772615	772688	772762	772835	772908	772981	73
593	773055	773128	773201	773274	773348	773421	773494	773567	773640	773713	73
594	773786	773860	773933	774006	774079	774152	774225	774298	774371	774444	73
595	774517	774590	774663	774736	774809	774882	774955	775028	775100	775173	73
596	775246	775319	775392	775465	775538	775610	775683	775756	775829	775902	73
597	775974	776047	776120	776193	776265	776338	776411	776483	776556	776629	73
598	776701	776774	776846	776919	776992	777064	777137	777209	777282	777354	73
599	777427	777499	777572	777644	777717	777789	777862	777934	778006	778079	72
600	778151	778224	778296	778368	778441	778513	778585	778658	778730	778802	72
601	778874	778947	779019	779091	779163	779236	779308	779380	779452	779524	72
602	779596	779669	779741	779813	779885	779957	780029	780101	780173	780245	72
603	780317	780389	780461	780533	780605	780677	780749	780821	780893	780965	72
604	781037	781109	781181	781253	781324	781396	781468	781540	781612	781684	72
605	781755	781827	781899	781971	782042	782114	782186	782258	782329	782401	72
606	782473	782544	782616	782688	782759	782831	782902	782974	783046	783117	72
607	783189	783260	783332	783403	783475	783546	783618	783689	783761	783832	71
608	783904	783975	784046	784118	784189	784261	784332	784403	784475	784546	71
609	784617	784689	784760	784831	784902	784974	785045	785116	785187	785259	71
No.	0	1	2	3	4	5	6	7	8	9	D.

D.	1	2	3	4	5	6	7	8	9	D.	1	2	3	4	5	6	7	8	9
71	7	14	21	28	35	43	50	57	64	75	7	15	22	30	37	45	52	60	67
72	7	14	22	29	36	43	50	58	65	76	8	15	23	30	38	46	53	61	68
73	7	15	22	29	36	44	51	58	66	77	8	15	23	31	38	46	54	62	69
74	7	15	22	30	37	44	52	59	67	78	8	16	23	31	39	47	55	62	70

LOGARITHMS OF NUMBERS

No. 6100 to 6649 Log. 785330 to 822756

No.	0	1	2	3	4	5	6	7	8	9	D.
610	785330	785401	785472	785543	785615	785686	785757	785828	785899	785970	71
611	786041	786112	786183	786254	786325	786396	786467	786538	786609	786680	71
612	786751	786822	786893	786964	787035	787106	787177	787248	787319	787390	71
613	787460	787531	787602	787673	787744	787815	787885	787956	788027	788098	71
614	788168	788239	788310	788381	788451	788522	788593	788663	788734	788804	71
615	788875	788946	789016	789087	789157	789228	789299	789369	789440	789510	71
616	789581	789651	789722	789792	789863	789933	790004	790074	790144	790215	70
617	790285	790356	790426	790496	790567	790637	790707	790778	790848	790918	70
618	790988	791059	791129	791199	791269	791340	791410	791480	791550	791620	70
619	791691	791761	791831	791901	791971	792041	792111	792181	792252	792322	70
620	792392	792462	792532	792602	792672	792742	792812	792882	792952	793022	70
621	793092	793162	793231	793301	793371	793441	793511	793581	793651	793721	70
622	793790	793860	793930	794000	794070	794139	794209	794279	794349	794418	70
623	794488	794558	794627	794697	794767	794836	794906	794976	795045	795115	70
624	795185	795254	795324	795393	795463	795532	795602	795672	795741	795811	70
625	795880	795949	796019	796088	796158	796227	796297	796366	796436	796505	69
626	796574	796644	796713	796782	796852	796921	796990	797060	797129	797198	69
627	797268	797337	797406	797475	797545	797614	797683	797752	797821	797890	69
628	797960	798029	798098	798167	798236	798305	798374	798443	798513	798582	69
629	798651	798720	798789	798858	798927	798996	799065	799134	799203	799272	69
630	799341	799409	799478	799547	799616	799685	799754	799823	799892	799961	69
631	800029	800098	800167	800236	800305	800373	800442	800511	800580	800648	69
632	800717	800786	800854	800923	800992	801061	801129	801198	801266	801335	69
633	801404	801472	801541	801609	801678	801747	801815	801884	801952	802021	69
634	802089	802158	802226	802295	802363	802432	802500	802568	802637	802705	69
635	802774	802842	802910	802979	803047	803116	803184	803252	803321	803389	68
636	803457	803525	803594	803662	803730	803798	803867	803935	804003	804071	68
637	804139	804208	804276	804344	804412	804480	804548	804616	804685	804753	68
638	804821	804889	804957	805025	805093	805161	805229	805297	805365	805433	68
639	805501	805569	805637	805705	805773	805841	805908	805976	806044	806112	68
640	806180	806248	806316	806384	806451	806519	806587	806655	806723	806790	68
641	806858	806926	806994	807061	807129	807197	807264	807332	807400	807467	68
642	807535	807603	807670	807738	807806	807873	807941	808008	808076	808143	68
643	808211	808279	808346	808414	808481	808549	808616	808684	808751	808818	67
644	808886	808953	809021	809088	809156	809223	809290	809358	809425	809492	67
645	809560	809627	809694	809762	809829	809896	809964	810031	810098	810165	67
646	810233	810300	810367	810434	810501	810569	810636	810703	810770	810837	67
647	810904	810971	811039	811106	811173	811240	811307	811374	811441	811508	67
648	811575	811642	811709	811776	811843	811910	811977	812044	812111	812178	67
649	812245	812312	812379	812445	812512	812579	812646	812713	812780	812847	67
650	812913	812980	813047	813114	813181	813247	813314	813381	813448	813514	67
651	813581	813648	813714	813781	813848	813914	813981	814048	814114	814181	67
652	814248	814314	814381	814447	814514	814581	814647	814714	814780	814847	67
653	814913	814980	815046	815113	815179	815246	815312	815378	815445	815511	66
654	815578	815644	815711	815777	815843	815910	815976	816042	816109	816175	66
655	816241	816308	816374	816440	816506	816573	816639	816705	816771	816838	66
656	816904	816970	817036	817102	817169	817235	817301	817367	817433	817499	66
657	817565	817631	817698	817764	817830	817896	817962	818028	818094	818160	66
658	818226	818292	818358	818424	818490	818556	818622	818688	818754	818820	66
659	818885	818951	819017	819083	819149	819215	819281	819346	819412	819478	66
660	819544	819610	819676	819741	819807	819873	819939	820004	820070	820136	66
661	820201	820267	820333	820399	820464	820530	820595	820661	820727	820792	66
662	820858	820924	820989	821055	821120	821186	821251	821317	821382	821448	66
663	821514	821579	821645	821710	821775	821841	821906	821972	822037	822103	65
664	822168	822233	822299	822364	822430	822495	822560	822626	822691	822756	65
No.	0	1	2	3	4	5	6	7	8	9	D.

D.	1	2	3	4	5	6	7	8	9
65	6	13	19	26	32	39	45	52	58
66	7	13	20	26	33	40	46	53	59
67	7	13	20	27	33	40	47	54	60
68	7	14	20	27	34	41	48	54	61

D.	1	2	3	4	5	6	7	8	9
68	7	14	20	27	34	41	48	54	61
69	7	14	21	28	34	41	48	55	62
70	7	14	21	28	35	42	49	56	63
71	7	14	21	28	35	43	50	57	64

LOGARITHMS OF NUMBERS

No. 6650 to 7199 — Log. 822822 to 857272

No.	0	1	2	3	4	5	6	7	8	9	D.
665	822822	822887	822952	823018	823083	823148	823213	823279	823344	823409	65
666	823474	823539	823605	823670	823735	823800	823865	823930	823996	824061	65
667	824126	824191	824256	824321	824386	824451	824516	824581	824646	824711	65
668	824776	824841	824906	824971	825036	825101	825166	825231	825296	825361	65
669	825426	825491	825556	825621	825686	825751	825815	825880	825945	826010	65
670	826075	826140	826204	826269	826334	826399	826464	826528	826593	826658	65
671	826723	826787	826852	826917	826981	827046	827111	827175	827240	827305	65
672	827369	827434	827499	827563	827628	827692	827757	827821	827886	827951	65
673	828015	828080	828144	828209	828273	828338	828402	828467	828531	828595	64
674	828660	828724	828789	828853	828918	828982	829046	829111	829175	829239	64
675	829304	829368	829432	829497	829561	829625	829690	829754	829818	829882	64
676	829947	830011	830075	830139	830204	830268	830332	830396	830460	830525	64
677	830589	830653	830717	830781	830845	830909	830973	831037	831102	831166	64
678	831230	831294	831358	831422	831486	831550	831614	831678	831742	831806	64
679	831870	831934	831998	832062	832126	832189	832253	832317	832381	832445	64
680	832509	832573	832637	832700	832764	832828	832892	832956	833020	833083	64
681	833147	833211	833275	833338	833402	833466	833530	833593	833657	833721	64
682	833784	833848	833912	833975	834039	834103	834166	834230	834294	834357	64
683	834421	834484	834548	834611	834675	834739	834802	834866	834929	834993	64
684	835056	835120	835183	835247	835310	835373	835437	835500	835564	835627	63
685	835691	835754	835817	835881	835944	836007	836071	836134	836197	836261	63
686	836324	836387	836451	836514	836577	836641	836704	836767	836830	836894	63
687	836957	837020	837083	837146	837210	837273	837336	837399	837462	837525	63
688	837588	837652	837715	837778	837841	837904	837967	838030	838093	838156	63
689	838219	838282	838345	838408	838471	838534	838597	838660	838723	838786	63
690	838849	838912	838975	839038	839101	839164	839227	839289	839352	839415	63
691	839478	839541	839604	839667	839729	839792	839855	839918	839981	840043	63
692	840106	840169	840232	840294	840357	840420	840482	840545	840608	840671	63
693	840733	840796	840859	840921	840984	841046	841109	841172	841234	841297	63
694	841359	841422	841485	841547	841610	841672	841735	841797	841860	841922	63
695	841985	842047	842110	842172	842235	842297	842360	842422	842484	842547	62
696	842609	842672	842734	842796	842859	842921	842983	843046	843108	843170	62
697	843233	843295	843357	843420	843482	843544	843606	843669	843731	843793	62
698	843855	843918	843980	844042	844104	844166	844229	844291	844353	844415	62
699	844477	844539	844601	844664	844726	844788	844850	844912	844974	845036	62
700	845098	845160	845222	845284	845346	845408	845470	845532	845594	845656	62
701	845718	845780	845842	845904	845966	846028	846090	846151	846213	846275	62
702	846337	846399	846461	846523	846585	846646	846708	846770	846832	846894	62
703	846955	847017	847079	847141	847202	847264	847326	847388	847449	847511	62
704	847573	847634	847696	847758	847819	847881	847943	848004	848066	848128	62
705	848189	848251	848312	848374	848435	848497	848559	848620	848682	848743	62
706	848805	848866	848928	848989	849051	849112	849174	849235	849297	849358	61
707	849419	849481	849542	849604	849665	849726	849788	849849	849911	849972	61
708	850033	850095	850156	850217	850279	850340	850401	850462	850524	850585	61
709	850646	850707	850769	850830	850891	850952	851014	851075	851136	851197	61
710	851258	851320	851381	851442	851503	851564	851625	851686	851747	851809	61
711	851870	851931	851992	852053	852114	852175	852236	852297	852358	852419	61
712	852480	852541	852602	852663	852724	852785	852846	852907	852968	853029	61
713	853090	853150	853211	853272	853333	853394	853455	853516	853577	853637	61
714	853698	853759	853820	853881	853941	854002	854063	854124	854185	854245	61
715	854306	854367	854428	854488	854549	854610	854670	854731	854792	854852	61
716	854913	854974	855034	855095	855156	855216	855277	855337	855398	855459	61
717	855519	855580	855640	855701	855761	855822	855882	855943	856003	856064	61
718	856124	856185	856245	856306	856366	856427	856487	856548	856608	856668	60
719	856729	856789	856850	856910	856970	857031	857091	857152	857212	857272	60
No.	0	1	2	3	4	5	6	7	8	9	D.

D.	1	2	3	4	5	6	7	8	9	D.	1	2	3	4	5	6	7	8	9
60	6	12	18	24	30	36	42	48	54	63	6	13	19	25	31	38	44	50	57
61	6	12	18	24	30	37	43	49	55	64	6	13	19	26	32	38	45	51	58
62	6	12	19	25	31	37	43	50	56	65	6	13	19	26	32	39	45	52	58

LOGARITHMS OF NUMBERS

No. 7200 to 7749 Log. 857332 to 889246

No.	0	1	2	3	4	5	6	7	8	9	D.
720	857332	857393	857453	857513	857574	857634	857694	857755	857815	857875	60
721	857935	857995	858056	858116	858176	858236	858297	858357	858417	858477	60
722	858537	858597	858657	858718	858778	858838	858898	858958	859018	859078	60
723	859138	859198	859258	859318	859379	859439	859499	859559	859619	859679	60
724	859739	859799	859859	859918	859978	860038	860098	860158	860218	860278	60
725	860338	860398	860458	860518	860578	860637	860697	860757	860817	860877	60
726	860937	860996	861056	861116	861176	861236	861295	861355	861415	861475	60
727	861534	861594	861654	861714	861773	861833	861893	861952	862012	862072	60
728	862131	862191	862251	862310	862370	862430	862489	862549	862608	862668	60
729	862728	862787	862847	862906	862966	863025	863085	863144	863204	863263	60
730	863323	863382	863442	863501	863561	863620	863680	863739	863799	863858	59
731	863917	863977	864036	864096	864155	864214	864274	864333	864392	864452	59
732	864511	864570	864630	864689	864748	864808	864867	864926	864985	865045	59
733	865104	865163	865222	865282	865341	865400	865459	865519	865578	865637	59
734	865696	865755	865814	865874	865933	865992	866051	866110	866169	866228	59
735	866287	866346	866405	866465	866524	866583	866642	866701	866760	866819	59
736	866878	866937	866996	867055	867114	867173	867232	867291	867350	867409	59
737	867467	867526	867585	867644	867703	867762	867821	867880	867939	867998	59
738	868056	868115	868174	868233	868292	868350	868409	868468	868527	868586	59
739	868644	868703	868762	868821	868879	868938	868997	869056	869114	869173	59
740	869232	869290	869349	869408	869466	869525	869584	869642	869701	869760	59
741	869818	869877	869935	869994	870053	870111	870170	870228	870287	870345	59
742	870404	870462	870521	870579	870638	870696	870755	870813	870872	870930	58
743	870989	871047	871106	871164	871223	871281	871339	871398	871456	871515	58
744	871573	871631	871690	871748	871806	871865	871923	871981	872040	872098	58
745	872156	872215	872273	872331	872389	872448	872506	872564	872622	872681	58
746	872739	872797	872855	872913	872972	873030	873088	873146	873204	873262	58
747	873321	873379	873437	873495	873553	873611	873669	873727	873785	873844	58
748	873902	873960	874018	874076	874134	874192	874250	874308	874366	874424	58
749	874482	874540	874598	874656	874714	874772	874830	874888	874945	875003	58
750	875061	875119	875177	875235	875293	875351	875409	875466	875524	875582	58
751	875640	875698	875756	875813	875871	875929	875987	876045	876102	876160	58
752	876218	876276	876333	876391	876449	876507	876564	876622	876680	876737	58
753	876795	876853	876910	876968	877026	877083	877141	877199	877256	877314	58
754	877371	877429	877487	877544	877602	877659	877717	877774	877832	877889	58
755	877947	878004	878062	878119	878177	878234	878292	878349	878407	878464	57
756	878522	878579	878637	878694	878752	878809	878866	878924	878981	879039	57
757	879096	879153	879211	879268	879325	879383	879440	879497	879555	879612	57
758	879669	879726	879784	879841	879898	879956	880013	880070	880127	880185	57
759	880242	880299	880356	880413	880471	880528	880585	880642	880699	880756	57
760	880814	880871	880928	880985	881042	881099	881156	881213	881271	881328	57
761	881385	881442	881499	881556	881613	881670	881727	881784	881841	881898	57
762	881955	882012	882069	882126	882183	882240	882297	882354	882411	882468	57
763	882525	882581	882638	882695	882752	882809	882866	882923	882980	883037	57
764	883093	883150	883207	883264	883321	883377	883434	883491	883548	883605	57
765	883661	883718	883775	883832	883888	883945	884002	884059	884115	884172	57
766	884229	884285	884342	884399	884455	884512	884569	884625	884682	884739	57
767	884795	884852	884909	884965	885022	885078	885135	885192	885248	885305	57
768	885361	885418	885474	885531	885587	885644	885700	885757	885813	885870	57
769	885926	885983	886039	886096	886152	886200	886265	886321	886378	886434	56
770	886491	886547	886604	886660	886716	886773	886829	886885	886942	886998	56
771	887054	887111	887167	887223	887280	887336	887392	887449	887505	887561	56
772	887617	887674	887730	887786	887842	887898	887955	888011	888067	888123	56
773	888179	888236	888292	888348	888404	888460	888516	888573	888629	888685	56
774	888741	888797	888853	888909	888965	889021	889077	889134	889190	889246	56
No	0	1	2	3	4	5	6	7	8	9	D.

D.	1	2	3	4	5	6	7	8	9
56	6	11	17	22	28	34	39	45	50
57	6	11	17	23	28	34	40	46	51
58	6	12	17	23	29	35	41	46	52

D.	1	2	3	4	5	6	7	8	9
59	6	12	18	24	29	35	41	47	53
60	6	12	18	24	30	36	42	48	54

LOGARITHMS OF NUMBERS

No. 7750 to 8299 Log 889302 to 919026

No.	0	1	2	3	4	5	6	7	8	9	D.
775	889302	889358	889414	889470	889526	889582	889638	889694	889750	889806	56
776	889862	889918	889974	890030	890086	890141	890197	890253	890309	890365	56
777	890421	890477	890533	890589	890645	890700	890756	890812	890868	890924	56
778	890980	891035	891091	891147	891203	891259	891314	891370	891426	891482	56
779	891537	891593	891649	891705	891760	891816	891872	891928	891983	892039	56
780	892095	892150	892206	892262	892317	892373	892429	892484	892540	892595	56
781	892651	892707	892762	892818	892873	892929	892985	893040	893096	893151	56
782	893207	893262	893318	893373	893429	893484	893540	893595	893651	893706	56
783	893762	893817	893873	893928	893984	894039	894094	894150	894205	894261	55
784	894316	894371	894427	894482	894538	894593	894648	894704	894759	894814	55
785	894870	894925	894980	895036	895091	895146	895201	895257	895312	895367	55
786	895423	895478	895533	895588	895644	895699	895754	895809	895864	895920	55
787	895975	896030	896085	896140	896195	896251	896306	896361	896416	896471	55
788	896526	896581	896636	896692	896747	896802	896857	896912	896967	897022	55
789	897077	897132	897187	897242	897297	897352	897407	897462	897517	897572	55
790	897627	897682	897737	897792	897847	897902	897957	898012	898067	898122	55
791	898176	898231	898286	898341	898396	898451	898506	898561	898615	898670	55
792	898725	898780	898835	898890	898944	898999	899054	899109	899164	899218	55
793	899273	899328	899383	899437	899492	899547	899602	899656	899711	899766	55
794	899821	899875	899930	899985	900039	900094	900149	900203	900258	900312	55
795	900367	900422	900476	900531	900586	900640	900695	900749	900804	900859	55
796	900913	900968	901022	901077	901131	901186	901240	901295	901349	901404	55
797	901458	901513	901567	901622	901676	901731	901785	901840	901894	901948	54
798	902003	902057	902112	902166	902221	902275	902329	902384	902438	902492	54
799	902547	902601	902655	902710	902764	902818	902873	902927	902981	903036	54
800	903090	903144	903199	903253	903307	903361	903416	903470	903524	903578	54
801	903633	903687	903741	903795	903849	903904	903958	904012	904066	904120	54
802	904174	904229	904283	904337	904391	904445	904499	904553	904607	904661	54
803	904716	904770	904824	904878	904932	904986	905040	905094	905148	905202	54
804	905256	905310	905364	905418	905472	905526	905580	905634	905688	905742	54
805	905796	905850	905904	905958	906012	906066	906119	906173	906227	906281	54
806	906335	906389	906443	906497	906551	906604	906658	906712	906766	906820	54
807	906874	906927	906981	907035	907089	907143	907196	907250	907304	907358	54
808	907411	907465	907519	907573	907626	907680	907734	907787	907841	907895	54
809	907949	908002	908056	908110	908163	908217	908270	908324	908378	908431	54
810	908485	908539	908592	908646	908699	908753	908807	908860	908914	908967	54
811	909021	909074	909128	909181	909235	909289	909342	909396	909449	909503	54
812	909556	909610	909663	909716	909770	909823	909877	909930	909984	910037	53
813	910091	910144	910197	910251	910304	910358	910411	910464	910518	910571	53
814	910624	910678	910731	910784	910838	910891	910944	910998	911051	911104	53
815	911158	911211	911264	911317	911371	911424	911477	911530	911584	911637	53
816	911690	911743	911797	911850	911903	911956	912009	912063	912116	912169	53
817	912222	912275	912328	912381	912435	912488	912541	912594	912647	912700	53
818	912753	912806	912859	912913	912966	913019	913072	913125	913178	913231	53
819	913284	913337	913390	913443	913496	913549	913602	913655	913708	913761	53
820	913814	913867	913920	913973	914026	914079	914132	914184	914237	914290	53
821	914345	914396	914449	914502	914555	914608	914660	914713	914766	914819	53
822	914872	914925	914977	915030	915083	915136	915189	915241	915294	915347	53
923	915400	915453	915505	915558	915611	915664	915716	915769	915822	915875	53
824	915927	915980	916033	916085	916138	916191	916243	916296	916349	916401	53
825	916454	916507	916559	916612	916664	916717	916770	916822	916875	916927	53
826	916980	917033	917085	917138	917190	917243	917295	917348	917400	917453	53
827	917506	917558	917611	917663	917716	917768	917820	917873	917925	917978	52
828	918030	918083	918135	918188	918240	918293	918345	918397	918450	918502	52
829	918555	918607	918659	918712	918764	918816	918869	918921	918973	919026	52
No.	0	1	2	3	4	5	6	7	8	9	D.

D.	1	2	3	4	5	6	7	8	9	D.	1	2	3	4	5	6	7	8	9
52	5	10	16	21	26	31	36	42	47	55	5	11	16	22	27	33	38	44	49
53	5	11	16	21	26	32	37	42	48	56	6	11	17	22	28	34	39	45	50
54	5	11	16	22	27	32	38	43	49										

LOGARITHMS OF NUMBERS

No. 8300 to 8849 — Log. 919078 to 946894

No	0	1	2	3	4	5	6	7	8	9	D
830	919078	919130	919183	919235	919287	919340	919392	919444	919496	919549	52
831	919601	919653	919706	919758	919810	919862	919914	919967	920019	920071	52
832	920123	920176	920228	920280	920332	920384	920436	920489	920541	920593	52
833	920645	920697	920749	920801	920853	920906	920958	921010	921062	921114	52
834	921166	921218	921270	921322	921374	921426	921478	921530	921582	921634	52
835	921686	921738	921790	921842	921894	921946	921998	922050	922102	922154	52
836	922206	922258	922310	922362	922414	922466	922518	922570	922622	922674	52
837	922725	922777	922829	922881	922933	922985	923037	923089	923140	923192	52
838	923244	923296	923348	923399	923451	923503	923555	923607	923658	923710	52
839	923702	923814	923865	923917	923969	924021	924072	924124	924176	924228	52
840	924279	924331	924383	924434	924486	924538	924589	924641	924693	924744	52
841	924796	924848	924899	924951	925003	925054	925106	925157	925209	925261	52
842	925312	925364	925415	925467	925518	925570	925621	925673	925725	925776	52
843	925828	925879	925931	925982	926034	926085	926137	926188	926240	926291	51
844	926342	926394	926445	926497	926548	926600	926651	926702	926754	926805	51
845	926857	926908	926959	927011	927062	927114	927165	927216	927268	927319	51
846	927370	927422	927473	927524	927576	927627	927678	927730	927781	927832	51
847	927883	927935	927986	928037	928088	928140	928191	928242	928293	928345	51
848	928396	928447	928498	928549	928601	928652	928703	928754	928805	928857	51
849	928908	928959	929010	929061	929112	929163	929215	929266	929317	929368	51
850	929419	929470	929521	929572	929623	929674	929725	929776	929827	929879	51
851	929930	929981	930032	930083	930134	930185	930236	930287	930338	930389	51
852	930440	930491	930542	930592	930643	930694	930745	930796	930847	930898	51
853	930949	931000	931051	931102	931153	931203	931254	931305	931356	931407	51
854	931458	931509	931560	931610	931661	931712	931763	931814	931865	931915	51
855	931966	932017	932068	932118	932169	932220	932271	932322	932372	932423	51
856	932474	932524	932575	932626	932677	932727	932778	932829	932879	932930	51
857	932981	933031	933082	933133	933183	933234	933285	933335	933386	933437	51
858	933487	933538	933589	933639	933690	933740	933791	933841	933892	933943	51
859	933993	934044	934094	934145	934195	934246	934296	934347	934397	934448	51
860	934498	934549	934599	934650	934700	934751	934801	934852	934902	934953	50
861	935003	935054	935104	935154	935205	935255	935306	935356	935406	935457	50
862	935507	935558	935608	935658	935709	935759	935809	935860	935910	935960	50
863	936011	936061	936111	936162	936212	936262	936313	936363	936413	936463	50
864	936514	936564	936614	936665	936715	936765	936815	936865	936916	936966	50
865	937016	937066	937117	937167	937217	937267	937317	937367	937418	937468	50
866	937518	937568	937618	937668	937718	937769	937819	937869	937919	937969	50
867	938019	938069	938119	938169	938219	938269	938319	938370	938420	938470	50
868	938520	938570	938620	938670	938720	938770	938820	938870	938920	938970	50
869	939020	939070	939120	939170	939220	939270	939320	939369	939419	939469	50
870	939519	939569	939619	939669	939719	939769	939819	939869	939918	939968	50
871	940018	940068	940118	940168	940218	940267	940317	940367	940417	940467	50
872	940516	940566	940616	940666	940716	940765	940815	940865	940915	940964	50
873	941014	941064	941114	941163	941213	941263	941313	941362	941412	941462	50
874	941511	941561	941611	941660	941710	941760	941809	941859	941909	941958	50
875	942008	942058	942107	942157	942207	942256	942306	942355	942405	942455	50
876	942504	942554	942603	942653	942702	942752	942801	942851	942901	942950	50
877	943000	943049	943099	943148	943198	943247	943297	943346	943396	943445	49
878	943495	943544	943593	943643	943692	943742	943791	943841	943890	943939	49
879	943989	944038	944088	944137	944186	944236	944285	944335	944384	944433	49
880	944483	944532	944581	944631	944680	944729	944779	944828	944877	944927	49
881	944976	945025	945074	945124	945173	945222	945272	945321	945370	945419	49
882	945469	945518	945567	945616	945665	945715	945764	945813	945862	945912	49
883	945961	946010	946059	946108	946157	946207	946256	946305	946354	946403	49
884	946452	946501	946551	946600	946649	946698	946747	946796	946845	946894	49
No.	0	1	2	3	4	5	6	7	8	9	D.

D.	1	2	3	4	5	6	7	8	9
49	5	10	15	20	24	29	34	39	44
50	5	10	15	20	25	30	35	40	45

D.	1	2	3	4	5	6	7	8	9
51	5	10	15	20	25	31	36	41	46
52	5	10	16	21	26	31	36	42	4

LOGARITHMS OF NUMBERS

No. 8850 to 9419 — Log. 946943 to 974005

No.	0	1	2	3	4	5	6	7	8	9	D.
885	946943	946992	947041	947090	947140	947189	947238	947287	947336	947385	49
886	947434	947483	947532	947581	947630	947679	947728	947777	947826	947875	49
887	947924	947973	948022	948070	948119	948168	948217	948266	948315	948364	49
888	948413	948462	948511	948560	948609	948657	948706	948755	948804	948853	49
889	948902	948951	948999	949048	949097	949146	949195	949244	949292	949341	49
890	949390	949439	949488	949536	949585	949634	949683	949731	949780	949829	49
891	949878	949926	949975	950024	950073	950121	950170	950219	950267	950316	49
892	950365	950414	950462	950511	950560	950608	950657	950706	950754	950803	49
893	950851	950900	950949	950997	951046	951095	951143	951192	951240	951289	49
894	951338	951386	951435	951483	951532	951580	951629	951677	951726	951775	49
895	951823	951872	951920	951969	952017	952066	952114	952163	952211	952260	48
896	952308	952356	952405	952453	952502	952550	952599	952647	952696	952744	48
897	952792	952841	952889	952938	952986	953034	953083	953131	953180	953228	48
898	953276	953325	953373	953421	953470	953518	953566	953615	953663	953711	48
899	953760	953808	953856	953905	953953	954001	954049	954098	954146	954194	48
900	954243	954291	954339	954387	954435	954484	954532	954580	954628	954677	48
901	954725	954773	954821	954869	954918	954966	955014	955062	955110	955158	48
902	955207	955255	955303	955351	955399	955447	955495	955543	955592	955640	48
903	955688	955736	955784	955832	955880	955928	955976	956024	956072	956120	48
904	956168	956216	956265	956313	956361	956409	956457	956505	956553	956601	48
905	956649	956697	956745	956793	956840	956888	956936	956984	957032	957080	48
906	957128	957176	957224	957272	957320	957368	957416	957464	957512	957559	48
907	957607	957655	957703	957751	957799	957847	957894	957942	957990	958038	48
908	958086	958134	958181	958229	958277	958325	958373	958421	958468	958516	48
909	958564	958612	958659	958707	958755	958803	958850	958898	958946	958994	48
910	959041	959089	959137	959185	959232	959280	959328	959375	959423	959471	48
911	959518	959566	959614	959661	959709	959757	959804	959852	959900	959947	48
912	959995	960042	960090	960138	960185	960233	960280	960328	960376	960423	48
913	960471	960518	960566	960613	960661	960709	960756	960804	960851	960899	48
914	960946	960994	961041	961089	961136	961184	961231	961279	961326	961374	47
915	961421	961469	961516	961563	961611	961658	961706	961753	961801	961848	47
916	961895	961943	961990	962038	962085	962132	962180	962227	962275	962322	47
917	962369	962417	962464	962511	962559	962606	962653	962701	962748	962795	47
918	962843	962890	962937	962985	963032	963079	963126	963174	963221	963268	47
919	963316	963363	963410	963457	963504	963552	963599	963646	963693	963741	47
920	963788	963835	963882	963929	963977	964024	964071	964118	964165	964212	47
921	964260	964307	964354	964401	964448	964495	964542	964590	964637	964684	47
922	964731	964778	964825	964872	964919	964966	965013	965061	965108	965155	47
923	965202	965249	965296	965343	965390	965437	965484	965531	965578	965625	47
924	965672	965719	965766	965813	965860	965907	965954	966001	966048	966095	47
925	966142	566189	966236	966283	966329	966376	966423	966470	966517	966564	47
926	966611	966658	966705	966752	966799	966845	966892	966939	966986	967033	47
927	967080	967127	967173	967220	967267	967314	967361	967408	967454	967501	47
928	967548	967595	967642	967688	967735	967782	967829	967875	967922	967969	47
929	968016	968062	968109	968156	968203	968249	968296	968343	968390	968436	47
930	968483	968530	968576	968623	968670	968716	968763	968810	968856	968903	47
931	968950	968996	969043	969090	969136	969183	969229	969276	969323	969369	47
932	969416	969463	969509	969556	969602	969649	969695	969742	969789	969835	47
933	969882	969928	969975	970021	970068	970114	970161	970207	970254	970300	47
934	970347	970393	970440	970486	970533	970579	970626	970672	970719	970765	46
935	970812	970858	970904	970951	970997	971044	971090	971137	971183	971229	46
936	971276	971322	971369	971415	971461	971508	971554	971601	971647	971693	46
937	971740	971786	971832	971879	971925	971971	972018	972064	972110	972157	46
938	972203	972249	972295	972342	972388	972434	972481	972527	972573	972619	46
939	972666	972712	972758	972804	972851	972897	972943	972989	973035	973082	46
940	973128	973174	973220	973266	973313	973359	973405	973451	973497	973543	46
941	973590	973636	973682	973728	973774	973820	973866	973913	973959	974005	46
No.	0	1	2	3	4	5	6	7	8	9	D.

D.	1	2	3	4	5	6	7	8	9	D.	1	2	3	4	5	6	7	8	9
46	5	9	14	18	23	28	32	37	41	48	5	10	14	19	24	29	34	38	43
47	5	9	14	19	23	28	33	38	42	49	5	10	15	20	24	29	34	39	44

LOGARITHMS OF NUMBERS

No. 9420 to 9999 Log. 974051 to 999957

No.	0	1	2	3	4	5	6	7	8	9	D.
942	974051	974097	974143	974189	974235	974281	974327	974374	974420	974466	46
943	974512	974558	974604	974650	974696	974742	974788	974834	974880	974926	46
944	974972	975018	975064	975110	975156	975202	975248	975294	975340	975386	46
945	975432	975478	975524	975570	975616	975662	975707	975753	975799	975845	46
946	975891	975937	975983	976029	976075	976121	976167	976212	976258	976304	46
947	976350	976396	976442	976488	976533	976579	976625	976671	976717	976763	46
948	976808	976854	976900	976946	976992	977037	977083	977129	977175	977220	46
949	977266	977312	977358	977403	977449	977495	977541	977586	977632	977678	46
950	977724	977769	977815	977861	977906	977952	977998	978043	978089	978135	46
951	978181	978226	978272	978317	978363	978409	978454	978500	978546	978591	46
952	978637	978683	978728	978774	978819	978865	978911	978956	979002	979047	46
953	979093	979138	979184	979230	979275	979321	979366	979412	979457	979503	46
954	979548	979594	979639	979685	979730	979776	979821	979867	979912	979958	46
955	980003	980049	980094	980140	980185	980231	980276	980322	980367	980412	45
956	980458	980503	980549	980594	980640	980685	980730	980776	980821	980867	45
957	980912	980957	981003	981048	981093	981139	981184	981229	981275	981320	45
958	981366	981411	981456	981501	981547	981592	981637	981683	981728	981773	45
959	981819	981864	981909	981954	982000	982045	982090	982135	982181	982226	45
960	982271	982316	982362	982407	982452	982497	982543	982588	982633	982678	45
961	982723	982769	982814	982859	982904	982949	982994	983040	983085	983130	45
962	983175	983220	983265	983310	983356	983401	983446	983491	983536	983581	45
963	983626	983671	983716	983762	983807	983852	983897	983942	983987	984032	45
964	984077	984122	984167	984212	984257	984302	984347	984392	984437	984482	45
965	984527	984572	984617	984662	984707	984752	984797	984842	984887	984932	45
966	984977	985022	985067	985112	985157	985202	985247	985292	985337	985382	45
967	985426	985471	985516	985561	985606	985651	985696	985741	985786	985830	45
968	985875	985920	985965	986010	986055	986100	986144	986189	986234	986279	45
969	986324	986369	986413	986458	986503	986548	986593	986637	986682	986727	45
970	986772	986817	986861	986906	986951	986996	987040	987085	987130	987175	45
971	987219	987264	987309	987353	987398	987443	987488	987532	987577	987622	45
972	987666	987711	987756	987800	987845	987890	987934	987979	988024	988068	45
973	988113	988157	988202	988247	988291	988336	988381	988425	988470	988514	45
974	988559	988604	988648	988693	988737	988782	988826	988871	988916	988960	45
975	989005	989049	989094	989138	989183	989227	989272	989316	989361	989405	45
976	989450	989494	989539	989583	989628	989672	989717	989761	989806	989850	44
977	989895	989939	989983	990028	990072	990117	990161	990206	990250	990294	44
978	990339	990383	990428	990472	990516	990561	990605	990650	990694	990738	44
979	990783	990827	990871	990916	990960	991004	991049	991093	991137	991182	44
980	991226	991270	991315	991359	991403	991448	991492	991536	991580	991625	44
981	991669	991713	991758	991802	991846	991890	991935	991979	992023	992067	44
982	992111	992156	992200	992244	992288	992333	992377	992421	992465	992509	44
983	992554	992598	992642	992686	992730	992774	992819	992863	992907	992951	44
984	992995	993039	993083	993127	993172	993216	993260	993304	993348	993392	44
985	993436	993480	993524	993568	993613	993657	993701	993745	993789	993833	44
986	993877	993921	993965	994009	994053	994097	994141	994185	994229	994273	44
987	994317	994361	994405	994449	994493	994537	994581	994625	994669	994713	44
988	994757	994801	994845	994889	994933	994977	995021	995065	995108	995152	44
989	995196	995240	995284	995328	995372	995416	995460	995504	995547	995591	44
990	995635	995679	995723	995767	995811	995854	995898	995942	995986	996030	44
991	996074	996117	996161	996205	996249	996293	996337	996380	996424	996468	44
992	996512	996555	996599	996643	996687	996731	996774	996818	996862	996907	44
993	996949	996993	997037	997080	997124	997168	997212	997255	997299	997343	44
994	997386	997430	997474	997517	997561	997605	997648	997692	997736	997779	44
995	997823	997867	997910	997954	997998	998041	998085	998129	998172	998216	44
996	998259	998303	998347	998390	998434	998477	998521	998564	998608	998652	44
997	998695	998739	998782	998826	998869	998913	998956	999000	999043	999087	44
998	999131	999174	999218	999261	999305	999348	999392	999435	999479	999522	44
999	999565	999609	999652	999696	999739	999783	999826	999870	999913	999957	43
No.	0	1	2	3	4	5	6	7	8	9	D.

D.	1	2	3	4	5	6	7	8	9	D.	1	2	3	4	5	6	7	8	9
43	4	9	13	17	21	26	30	34	39	45	4	9	13	18	22	27	31	36	40
44	4	9	13	18	22	26	31	35	40	46	5	9	14	18	23	28	32	37	41

SPHEROIDAL TABLES. COMPRESSION $\frac{1}{294}$.

Latitude.					Longitude.				
Latitude.	Length of one degree in statute miles.	Length in feet of a			Latitude.	Length of one degree in minutes of latitude or nautical miles.*	Length in feet of a		
		Degree.	Minute.	Second.			Degree.	Minute.	Second.
0°	68·704	362755·6	6045·93	100·77	0°	60·410	365233·7	6087·23	101·454
2	68·704	362760·1	6046·00	100·77	2	60·373	365012·7	6083·54	101·392
4	68·707	362773·6	6046·23	100·77	4	60·261	364350·0	6072·50	101·208
6	68·711	362795·9	6046·60	100·78	6	60·074	363246·3	6054·11	100·902
8	68·717	362827·1	6047·12	100·79	8	59·814	361703·0	6028·38	100·473
10	68·725	362866·9	6047·78	100·80	10	59·480	359721·7	5995·36	99·923
12	68·734	362815·2	6048·59	100·81	12	59·072	357304·8	5955·08	99·251
14	68·745	362971·8	6049·53	100·83	14	58·592	354455·1	5907·59	98·460
16	68·757	363036·3	6050·61	100·84	16	58·040	351175·7	5852·93	97·549
18	68·771	363108·4	6051·81	100·86	18	57·416	347470·5	5791·18	96·520
20	68·786	363187·9	6053·13	100·89	20	56·722	343343·7	5722·40	95·373
22	68·801	363274·3	6054·57	100·91	22	55·958	338800·1	5646·67	94·111
24	68·819	363367·2	6056·12	100·94	24	55·125	333845·0	5564·08	92·735
26	68·838	363466·2	6057·77	100·96	26	54·225	328484·1	5474·74	91·245
28	68·858	363570·8	6059·51	100·99	28	53·259	322723·6	5378·73	89·645
30	68·879	363680·5	6061·34	101·02	30	52·228	316570·3	5276·17	87·936
32	68·900	363794·8	6063·25	101·05	32	51·133	310031·2	5167·19	86·119
34	68·923	363913·1	6065·22	101·09	34	49·976	303114·2	5051·90	84·198
36	68·946	364034·9	6067·25	101·12	36	48·758	295827·2	4930·45	82·174
38	68·970	364159·5	6069·33	101·16	38	47·481	288178·9	4802·98	80·050
40	68·994	364286·3	6071·44	101·19	40	46·146	280178·2	4669·64	77·827
42	69·018	364414·9	6073·58	101·23	42	44·757	271834·7	4530·58	75·509
44	69·042	364544·4	6075·74	101·26	44	43·313	263158·3	4385·97	73·100
46	69·067	364674·4	6077·91	101·30	46	41·817	254159·2	4235·99	70·600
48	69·092	364804·1	6080·07	101·33	48	40·270	244848·2	4080·80	68·013
50	69·116	364932·9	6082·22	101·37	50	38·676	235236·5	3920·61	65·343
52	69·140	365060·2	6084·34	101·41	52	37·035	225335·5	3755·59	62·593
54	69·164	365185·4	6086·42	101·44	54	35·350	215157·2	3585·95	59·706
56	69·187	365307·9	6088·47	101·47	56	33·623	204714·0	3411·90	56·865
58	69·210	365427·0	6090·45	101·51	58	31·856	19,018·3	3233·64	53·891
60	69·231	365542·2	6092·37	101·54	60	30·051	183083·3	3051·39	50·856
62	69·252	365652·9	6094·22	101·57	62	28·211	171922·1	2865·37	47·756
64	69·272	365758·5	6095·98	101·60	64	26·337	160548·6	2675·81	44·597
66	69·291	365858·6	6097·64	101·63	66	24·432	148976·3	2482·94	41·382
68	69·309	365952·7	6099·21	101·65	68	22·498	137219·7	2287·00	38·116
70	69·326	366040·2	6100·67	101·68	70	20·538	125293·2	2088·22	34·804
72	69·341	366120·7	6102·01	101·70	72	18·553	113211·4	1886·86	31·448
74	69·355	366193·9	6103·23	101·72	74	16·547	100989·1	1683·15	28·053
76	69·367	366259·6	6104·32	101·74	76	14·521	88641·6	1477·36	24·623
78	69·378	366316·7	6105·28	101·75	78	12·478	76184·0	1269·73	21·162
80	69·387	366365·8	6106·10	101·77	80	10·421	63631·8	1060·53	17·676
82	69·395	366,06·3	6106·77	101·78	82	8·352	51000·6	850·01	14·167
84	69·401	366438·0	6107·30	101·79	84	6·272	38306·1	638·44	10·641
86	69·405	366460·7	6107·68	101·79	86	4·186	25563·9	426·07	7·101
88	69·408	366474·4	6107·91	101·80	88	2·094	1·789·9	213·17	3·553
90	69·409	366479·0	6107·98	101·80	90	0·0	0·0	0·0	0·0

* The figures in this column, divided by 6, will give the length, in cables, of a minute of longitude in it's corresponding latitude, thus: in latitude 84° 6·272 ÷ 6 = 1·05 cable in a minute of longitude.

NOTE.—These tables have been calculated for every ten minutes of latitude, and are published by J. D. Potter, 145 Minories, E.

TABLE 65.

NATURAL SINES, COSINES, &c.

°	Sine.	Cosec.	Tangent.	Cotang.	Secant.	Cosine.	°
0	·0000	Infinite	·0000	Infinite	1·0000	1·0000	90
1	·0175	57·2987	·0175	57·2900	1·0002	·9998	89
2	·0349	28·6537	·0349	28·6363	1·0006	·9994	88
3	·0523	19·1073	·0524	19·0811	1·0014	·9986	87
4	·0698	14·3356	·0699	14·3007	1·0024	·9976	86
5	·0872	11·4737	·0875	11·4301	1·0038	·9962	85
6	·1045	9·5668	·1051	9·5144	1·0055	·9945	84
7	·1219	8·2055	·1228	8·1443	1·0075	·9925	83
8	·1392	7·1853	·1405	7·1154	1·0098	·9903	82
9	·1564	6·3925	·1584	6·3138	1·0125	·9877	81
10	·1736	5·7588	·1763	5·6713	1·0154	·9848	80
11	·1908	5·2408	·1944	5·1446	1·0187	·9816	79
12	·2079	4·8097	·2126	4·7046	1·0223	·9781	78
13	·2250	4·4454	·2309	4·3315	1·0263	·9744	77
14	·2419	4·1336	·2493	4·0108	1·0306	·9703	76
15	·2588	3·8637	·2679	3·7321	1·0353	·9659	75
16	·2756	3·6280	·2867	3·4874	1·0403	·9613	74
17	·2924	3·4203	·3057	3·2709	1·0457	·9563	73
18	·3090	3·2361	·3249	3·0777	1·0515	·9511	72
19	·3256	3·0716	·3443	2·9042	1·0570	·9455	71
20	·3420	2·9238	·3640	2·7475	1·0642	·9397	70
21	·3584	2·7904	·3839	2·6051	1·0711	·9336	69
22	·3746	2·6695	·4040	2·4751	1·0785	·9272	68
23	·3907	2·5593	·4245	2·3559	1·0864	·9205	67
24	·4067	2·4586	·4452	2·2460	1·0946	·9135	66
25	·4226	2·3662	·4663	2·1445	1·1034	·9063	65
26	·4384	2·2812	·4877	2·0503	1·1126	·8988	64
27	·4540	2·2027	·5095	1·9626	1·1223	·8910	63
28	·4695	2·1301	·5317	1·8807	1·1326	·8829	62
29	·4848	2·0627	·5543	1·8040	1·1434	·8746	61
30	·5000	2·0000	·5774	1·7320	1·1547	·8660	60
31	·5150	1·9416	·6009	1·6643	1·1666	·8572	59
32	·5299	1·8871	·6249	1·6003	1·1792	·8480	58
33	·5446	1·8361	·6494	1·5399	1·1924	·8387	57
34	·5592	1·7883	·6745	1·4826	1·2062	·8290	56
35	·5736	1·7434	·7002	1·4281	1·2208	·8192	55
36	·5878	1·7013	·7265	1·3764	1·2361	·8090	54
37	·6018	1·6616	·7536	1·3270	1·2521	·7986	53
38	·6157	1·6243	·7813	1·2799	1·2690	·7880	52
39	·6293	1·5890	·8098	1·2349	1·2868	·7771	51
40	·6428	1·5572	·8391	1·1918	1·3054	·7660	50
41	·6561	1·5243	·8693	1·1504	1·3250	·7547	49
42	·6691	1·4945	·9004	1·1106	1·3456	·7431	48
43	·6820	1·4663	·9325	1·0724	1·3673	·7314	47
44	·6947	1·4396	·9657	1·0355	1·3902	·7193	46
45	·7071	1·4142	1·0000	1·0000	1·4142	·7071	45
°	Cosine.	Secant.	Cotang.	Tangent.	Cosec.	Sine	°

LOG SINES OF SMALL ARCS TO EACH SECOND

″	0° 0′	0° 1′	0° 2′	0° 3′	0° 4′	0° 5′	0° 6′	0° 7′	0° 8′	0° 9′	″
		6·	6·		7·	7·	7·	7·	7·	7·	
0	— ∞	46373	76476	6·94085	06579	16270	24188	30882	36682	41797	60
1	4·68557	47090	76836	6·94325	06759	16414	24308	30986	36772	41877	59
2	4·98660	47797	77193	6·94565	06939	16558	24428	31089	36862	41957	58
3	5·16270	48492	77548	6·94803	07118	16702	24548	31191	36952	42037	57
4	5·28763	49175	77900	6·95039	07296	16845	24668	31294	37042	42117	56
5	5·38454	49849	78248	6·95275	07474	16987	24787	31396	37132	42197	55
6	5·46373	50512	78595	6·95509	07651	17130	24906	31498	37221	42277	54
7	5·53067	51165	78938	6·95742	07827	17271	25024	31600	37310	42356	53
8	5·58866	51808	79278	6·95973	08003	17413	25142	31702	37399	42435	52
9	5·63982	52442	79616	6·96204	08177	17553	25260	31803	37488	42515	51
10	5·68557	53067	79952	6·96433	08351	17694	25378	31904	37577	42594	50
11	5·72697	53683	80285	6·96661	08525	17834	25495	32005	37666	42673	49
12	5·76476	54291	80615	6·96888	08698	17973	25612	32106	37754	42751	48
13	5·79952	54890	80943	6·97113	08870	18112	25728	32206	37842	42830	47
14	5·83170	55481	81268	6·97338	09041	18250	25845	32306	37930	42908	46
15	5·86167	56064	81591	6·97561	09211	18389	25961	32406	38018	42987	45
16	5·88969	56639	81911	6·97783	09381	18526	26076	32506	38106	43065	44
17	5·91602	57207	82230	6·98004	09551	18663	26192	32606	38193	43143	43
18	5·94085	57767	82545	6·98224	09719	18800	26307	32705	38280	43221	42
19	5·96433	58320	82859	6·98443	09887	18937	26421	32804	38367	43299	41
20	5·98660	58866	83170	6·98660	10055	19072	26536	32903	38454	43376	40
21	6·00779	59406	83479	6·98877	10222	19208	26650	33001	38541	43454	39
22	6·02800	59939	83786	6·99093	10388	19343	26764	33100	38628	43531	38
23	6·04730	60465	84091	6·99307	10553	19478	26877	33198	38714	43608	37
24	6·06579	60985	84394	6·99520	10718	19612	26991	33296	38800	43685	36
25	6·08351	61499	84694	6·99733	10882	19746	27104	33393	38887	43762	35
26	6·10055	62007	84993	6·99944	11046	19879	27216	33491	38972	43839	34
27	6·11694	62509	85289	7·00155	11209	20012	27329	33588	39058	43916	33
28	6·13273	63006	85584	7·00364	11371	20145	27441	33685	39144	43992	32
29	6·14797	63496	85876	7·00572	11533	20277	27552	33782	39229	44069	31
30	6·16270	63982	86167	7·00779	11694	20409	27664	33879	39314	44145	30
31	6·17694	64462	86455	7·00986	11854	20540	27775	33975	39400	44221	29
32	6·19072	64936	86742	7·01191	12014	20671	27886	34071	39484	44297	28
33	6·20409	65406	87027	7·01395	12174	20802	27997	34167	39569	44373	27
34	6·21705	65870	87310	7·01599	12333	20932	28107	34263	39654	44449	26
35	6·22964	66330	87591	7·01801	12491	21062	28217	34359	39738	44524	25
36	6·24188	66785	87870	7·02003	12648	21191	28327	34454	39822	44600	24
37	6·25378	67235	88147	7·02203	12805	21320	28437	34549	39906	44675	23
38	6·26536	67680	88423	7·02403	12962	21449	28546	34644	39990	44750	22
39	6·27664	68121	88697	7·02602	13118	21577	28655	34739	40074	44825	21
40	6·28763	68557	88969	7·02800	13273	21705	28763	34833	40158	44900	20
41	6·29836	68990	89240	7·02997	13428	21833	28872	34928	40241	44975	19
42	6·30882	69418	89509	7·03193	13582	21960	28980	35022	40324	45050	18
43	6·31904	69841	89776	7·03388	13736	22087	29088	35116	40408	45124	17
44	6·32903	70261	90042	7·03582	13889	22213	29196	35209	40491	45199	16
45	6.33879	70676	90306	7·03776	14042	22339	29303	35303	40573	45273	15
46	6·34833	71088	90568	7·03968	14194	22465	29410	35396	40656	45347	14
47	6·35767	71496	90829	7·04160	14346	22590	29517	35489	40739	45421	13
48	6·36682	71900	91088	7·04351	14497	22715	29623	35582	40821	45495	12
49	6·37577	72300	91346	7·04541	14647	22840	29730	35675	40903	45569	11
50	6·38454	72697	91602	7·04730	14797	22964	29836	35767	40985	45643	10
51	6·39315	73090	91857	7·04919	14947	23088	29942	35860	41067	45716	9
52	6·40158	73479	92110	7·05106	15096	23212	30047	35952	41149	45790	8
53	6·40985	73865	92362	7·05293	15244	23335	30152	36044	41230	45863	7
54	6·41797	74248	92612	7·05479	15392	23458	30257	36135	41312	45936	6
55	6·42594	74627	92861	7·05664	15540	23580	30362	36227	41393	46009	5
56	6·43376	75003	93109	7·05849	15687	23702	30467	36318	41474	46082	4
57	6·44145	75376	93355	7·06032	15833	23824	30571	36409	41555	46155	3
58	6·44900	75746	93599	7·06215	15979	23946	30675	36500	41636	46228	2
59	6·45643	76112	93843	7·06397	16125	24067	30779	36591	41716	46300	1
60	6·46373	76476	94085	7·06579	16270	24188	30882	36682	41797	46373	0
″	89° 59′	89° 58′	89° 57′	89° 56′	89° 55′	89° 54′	89° 53′	89° 52′	89° 51′	89° 50′	″

COSINE

LOG. SINES OF SMALL ARCS TO EACH SECOND

″	0° 10′	0° 11′	0° 12′	0° 13′	0° 14′	0° 15′	0° 16′	0° 17′	0° 18′	0° 19′	″
	7.	7.	7.	7.	7.	7.	7.	7.	7.	7.	
0	46373	50512	54291	57767	60985	63982	66784	69417	71900	74248	60
1	46445	50578	54351	57822	61037	64030	66830	69460	71940	74286	59
2	46517	50643	54411	57878	61089	64078	66875	69502	71980	74324	58
3	46589	50709	54471	57934	61140	64126	66920	69545	72020	74362	57
4	46661	50774	54531	57989	61192	64174	66965	69587	72060	74400	56
5	46733	50840	54591	58044	61243	64222	67010	69630	72100	74438	55
6	46805	50905	54651	58100	61294	64270	67055	69672	72140	74476	54
7	46876	50970	54711	58155	61346	64318	67100	69714	72180	74514	53
8	46948	51035	54771	58210	61397	64366	67145	69757	72220	74551	52
9	47019	51100	54830	58265	61448	64414	67190	69799	72260	74589	51
10	47090	51165	54890	58320	61499	64461	67234	69841	72300	74627	50
11	47162	51230	54949	58375	61550	64509	67279	69883	72340	74665	49
12	47233	51294	55008	58430	61601	64557	67324	69925	72380	74703	48
13	47303	51359	55068	58485	61652	64604	67369	69967	72419	74740	47
14	47374	51423	55127	58539	61703	64652	67413	70009	72459	74778	46
15	47445	51488	55186	58594	61754	64699	67458	70051	72499	74815	45
16	47515	51552	55245	58649	61805	64747	67502	70093	72538	74853	44
17	47586	51616	55304	58703	61855	64794	67547	70135	72578	74891	43
18	47656	51680	55363	58758	61906	64842	67591	70177	72618	74928	42
19	47726	51744	55422	58812	61957	64889	67636	70219	72657	74966	41
20	47797	51808	55481	58866	62007	64936	67680	70261	72697	75003	40
21	47867	51872	55539	58921	62058	64983	67724	70302	72736	75040	39
22	47936	51936	55598	58975	62108	65030	67768	70344	72775	75078	38
23	48006	51999	55656	59029	62158	65078	67813	70386	72815	75115	37
24	48076	52063	55715	59083	62209	65125	67857	70427	72854	75153	36
25	48145	52126	55773	59137	62259	65172	67901	70469	72894	75190	35
26	48215	52190	55831	59191	62309	65218	67945	70510	72933	75227	34
27	48284	52253	55889	59245	62359	65265	67989	70552	72972	75264	33
28	48353	52316	55948	59299	62409	65312	68033	70593	73011	75302	32
29	48422	52379	56006	59352	62459	65359	68077	70635	73050	75339	31
30	48491	52442	56064	59406	62509	65406	68121	70676	73090	75376	30
31	48560	52505	56121	59459	62559	65452	68165	70718	73129	75413	29
32	48629	52568	56179	59513	62609	65499	68208	70759	73168	75450	28
33	48698	52631	56237	59566	62659	65545	68252	70800	73207	75487	27
34	48766	52693	56295	59620	62708	65592	68296	70841	73246	75524	26
35	48835	52756	56352	59673	62758	65638	68340	70883	73285	75561	25
36	48903	52818	56410	59726	62808	65685	68383	70924	73324	75598	24
37	48971	52881	56467	59780	62857	65731	68427	70965	73363	75635	23
38	49039	52943	56524	59833	62907	65778	68470	71006	73401	75672	22
39	49107	53005	56582	59886	62956	65824	68514	71047	73440	75709	21
40	49175	53067	56639	59939	63006	65870	68557	71088	73479	75745	20
41	49243	53129	56696	59992	63055	65916	68601	71129	73518	75782	19
42	49311	53191	56753	60045	63104	65962	68644	71170	73557	75819	18
43	49379	53253	56810	60097	63153	66008	68687	71211	73595	75856	17
44	49446	53315	56867	60150	63203	66055	68731	71251	73634	75892	16
45	49513	53376	56924	60203	63252	66101	68774	71292	73673	75929	15
46	49581	53438	56980	60255	63301	66146	68817	71333	73711	75966	14
47	49648	53499	57037	60308	63350	66192	68860	71374	73750	76002	13
48	49715	53561	57094	60360	63399	66238	68903	71414	73788	76039	12
49	49782	53622	57150	60413	63448	66284	68946	71455	73827	76075	11
50	49849	53683	57206	60465	63496	66330	68989	71496	73865	76112	10
51	49916	53744	57263	60517	63545	66375	69032	71536	73904	76148	9
52	49982	53805	57319	60570	63594	66421	69075	71577	73942	76185	8
53	50049	53866	57375	60622	63642	66467	69118	71617	73980	76221	7
54	50115	53927	57431	60674	63691	66512	69161	71658	74019	76258	6
55	50182	53988	57488	60726	63740	66558	69204	71698	74057	76294	5
56	50248	54049	57544	60778	63788	66603	69247	71739	74095	76330	4
57	50314	54109	57599	60830	63837	66649	69289	71779	74133	76367	3
58	50380	54170	57655	60882	63885	66694	69332	71819	74171	76403	2
59	50446	54230	57711	60934	63933	66739	69375	71859	74210	76439	1
60	50512	54291	57767	60985	63982	66784	69417	71900	74248	76475	0
″	89° 49′	89° 48′	89° 47′	89° 46′	89° 45′	89° 44′	89° 43′	89° 42′	89° 41′	89° 40′	″

COSINE

LOG. SINES OF SMALL ARCS TO EACH SECOND

″	0° 20′	0° 21′	0° 22′	0° 23′	0° 24′	0° 25′	0° 26′	0° 27′	0° 28′	0° 29′	″
	7.	7.	7.	7.	7.	7.	7.	7.	7.	7.	
0	76475	78594	80615	82545	84393	86166	87870	89509	91088	92612	60
1	76512	78629	80647	82577	84424	86195	87897	89535	91114	92637	59
2	76548	78663	80680	82608	84454	86224	87925	89562	91140	92662	58
3	76584	78698	80713	82639	84484	86253	87953	89589	91165	92687	57
4	76620	78732	80746	82671	84514	86282	87981	89616	91191	92712	56
5	76656	78766	80779	82702	84544	86311	88008	89642	91217	92737	55
6	76692	78801	80812	82733	84574	86340	88036	89669	91243	92761	54
7	76728	78835	80844	82765	84604	86368	88064	89696	91269	92786	53
8	76764	78869	80877	82796	84634	86397	88092	89722	91294	92811	52
9	76800	78903	80910	82827	84664	86426	88119	89749	91320	92836	51
10	76836	78938	80942	82859	84694	86455	88147	89776	91346	92861	50
11	76872	78972	80975	82890	84724	86484	88175	89802	91371	92886	49
12	76907	79006	81008	82921	84754	86512	88202	89829	91397	92910	48
13	76943	79040	81040	82952	84784	86541	88230	89856	91423	92935	47
14	76979	79074	81073	82983	84814	86570	88258	89882	91448	92960	46
15	77015	79108	81105	83015	84843	86598	88285	89909	91474	92985	45
16	77051	79142	81138	83046	84873	86627	88313	89935	91500	93009	44
17	77086	79176	81170	83077	84903	86656	88340	89962	91525	93034	43
18	77122	79210	81203	83108	84933	86684	88368	89988	91551	93059	42
19	77158	79244	81235	83139	84963	86713	88395	90015	91576	93084	41
20	77193	79278	81268	83170	84992	86741	88423	90041	91602	93108	40
21	77229	79312	81300	83201	85022	86770	88450	90068	91627	93133	39
22	77264	79346	81332	83232	85052	86799	88478	90094	91653	93158	38
23	77300	79380	81365	83263	85082	86827	88505	90121	91678	93182	37
24	77335	79414	81397	83294	85111	86856	88533	90147	91704	93207	36
25	77371	79448	81429	83325	85141	86884	88560	90174	91729	93231	35
26	77406	79481	81462	83356	85171	86913	88587	90200	91755	93256	34
27	77442	79515	81494	83387	85200	86941	88615	90226	91780	93281	33
28	77477	79549	81526	83417	85230	86969	88642	90253	91806	93305	32
29	77512	79582	81558	83448	85259	86998	88669	90279	91831	93330	31
30	77548	79616	81591	83479	85289	87026	88697	90305	91857	93354	30
31	77583	79650	81623	83510	85318	87055	88724	90332	91882	93379	29
32	77618	79683	81655	83541	85348	87083	88751	90358	91907	93403	28
33	77654	79717	81687	83571	85377	87111	88779	90384	91933	93428	27
34	77689	79751	81719	83602	85407	87140	88806	90411	91958	93452	26
35	77724	79784	81751	83633	85436	87168	88833	90437	91983	93477	25
36	77759	79818	81783	83663	85466	87196	88860	90463	92009	93501	24
37	77794	79851	81815	83694	85495	87224	88888	90489	92034	93526	23
38	77829	79885	81847	83725	85525	87253	88915	90515	92059	93550	22
39	77864	79918	81879	83755	85554	87281	88942	90542	92085	93575	21
40	77899	79952	81911	83786	85583	87309	88969	90568	92110	93599	20
41	77934	79985	81943	83817	85613	87337	88996	90594	92135	93623	19
42	77969	80018	81975	83847	85642	87366	89023	90620	92160	93648	18
43	78004	80052	82007	83878	85671	87394	89050	90646	92186	93672	17
44	78039	80085	82039	83908	85700	87422	89077	90672	92211	93696	16
45	78074	80118	82070	83939	85730	87450	89105	90698	92236	93721	15
46	78109	80152	82102	83969	85759	87478	89132	90725	92261	93745	14
47	78144	80185	82134	84000	85788	87506	89159	90751	92286	93769	13
48	78179	80218	82166	84030	85817	87534	89186	90777	92311	93794	12
49	78213	80251	82198	84060	85847	87562	89213	90803	92336	93818	11
50	78248	80284	82229	84091	85876	87590	89240	90829	92362	93842	10
51	78283	80317	82261	84121	85905	87618	89267	90855	92387	93866	9
52	78318	80351	82293	84151	85934	87646	89294	90881	92412	93891	8
53	78352	80384	82324	84182	85963	87674	89320	90907	92437	93915	7
54	78387	80417	82356	84212	85992	87702	89347	90933	92462	93939	6
55	78422	80450	82387	84242	86021	87730	89374	90958	92487	93963	5
56	78456	80483	82419	84273	86050	87758	89401	90984	92512	93988	4
57	78491	80516	82451	84303	86079	87786	89428	91010	92537	94012	3
58	78525	80549	82482	84333	86108	87814	89455	91036	92562	94036	2
59	78560	80582	82514	84363	86137	87842	89482	91062	92587	94060	1
60	78594	80615	82545	84393	86166	87870	89509	91088	92612	94084	0
″	89° 39′	89° 38′	89° 37′	89° 36′	89° 35′	89° 34′	89° 33′	89° 32′	89° 31′	89° 30′	″

Cosine

LOG. SINES OF SMALL ARCS TO EACH SECOND

″	0° 30′	0° 31′	0° 32′	0° 33′	0° 34′	0° 35′	0° 36′	0° 37′	0° 38′	0° 39′	″
	–	7·	7·	7·		8·	8·	8·	8·	8·	
0	94084	95508	96887	98223	7·99520	00779	02002	03192	04350	05478	60
1	94108	95532	96910	98245	7·99541	00799	02022	03211	04369	05497	59
2	94132	95555	96932	98267	7·99562	00820	02042	03231	04388	05515	58
3	94157	95578	96955	98289	7·99584	00841	02062	03251	04407	05534	57
4	94181	95601	96977	98311	7·99605	00861	02082	03270	04426	05552	56
5	94205	95625	97000	98333	7·99626	00882	02102	03290	04445	05571	55
6	94229	95648	97022	98355	7·99647	00903	02123	03309	04464	05589	54
7	94253	95671	97045	98377	7·99669	00923	02143	03329	04483	05608	53
8	94277	95695	97068	98398	7·99690	00944	02163	03348	04502	05626	52
9	94301	95718	97090	98420	7·99711	00964	02183	03368	04521	05645	51
10	94325	95741	97113	98442	7·99732	00985	02203	03387	04540	05663	50
11	94349	95764	97135	98464	7·99753	01006	02223	03407	04559	05682	49
12	94373	95787	97158	98486	7·99775	01026	02243	03426	04578	05700	48
13	94397	95811	97180	98508	7·99796	01047	02263	03446	04597	05719	47
14	94421	95834	97202	98529	7·99817	01067	02283	03465	04616	05737	46
15	94445	95857	97225	98551	7·99838	01088	02303	03484	04635	05756	45
16	94469	95880	97247	98573	7·99859	01108	02323	03504	04654	05774	44
17	94492	95903	97270	98595	7·99880	01129	02343	03523	04673	05792	43
18	94516	95926	97292	98616	7·99901	01149	02362	03543	04692	05811	42
19	94540	95950	97315	98638	7·99922	01170	02382	03562	04710	05829	41
20	94564	95973	97337	98660	7·99943	01190	02402	03581	04729	05848	40
21	94588	95996	97359	98682	7·99965	01211	02422	03601	04748	05866	39
22	94612	96019	97382	98703	7·99986	01231	02442	03620	04767	05885	38
23	94636	96042	97404	98725	8·00007	01252	02462	03640	04786	05903	37
24	94659	96065	97426	98747	8·00028	01272	02482	03659	04805	05921	36
25	94683	96088	97449	98768	8·00049	01293	02502	03678	04824	05940	35
26	94707	96111	97471	98790	8·00070	01313	02522	03698	04843	05958	34
27	94731	96134	97493	98812	8·00091	01333	02542	03717	04861	05976	33
28	94755	96157	97516	98833	8·00112	01354	02561	03736	04880	05995	32
29	94778	96180	97538	98855	8·00133	01374	02581	03756	04899	06013	31
30	94802	96203	97560	98876	8·00154	01395	02601	03775	04918	06031	30
31	94826	96226	97583	98898	8·00175	01415	02621	03794	04937	06050	29
32	94849	96249	97605	98920	8·00196	01435	02641	03813	04955	06068	28
33	94873	96272	97627	98941	8·00217	01456	02661	03833	04974	06086	27
34	94897	96295	97649	98963	8·00238	01476	02680	03852	04993	06105	26
35	94921	96318	97672	98984	8·00259	01496	02700	03871	05012	06123	25
36	94944	96341	97694	99006	8·00279	01517	02720	03891	05030	06141	24
37	94968	96364	97716	99027	8·00300	01537	02740	03910	05049	06159	23
38	94991	96386	97738	99049	8·00321	01557	02759	03929	05068	06178	22
39	95015	96409	97760	99070	8·00342	01578	02779	03948	05087	06196	21
40	95039	96432	97782	99092	8·00363	01598	02799	03967	05105	06214	20
41	95062	96455	97805	99113	8·00384	01618	02819	03987	05124	06232	19
42	95086	96478	97827	99135	8·00405	01639	02838	04006	05143	06251	18
43	95109	96501	97849	99156	8·00426	01659	02858	04025	05161	06269	17
44	95133	96524	97871	99178	8·00447	01679	02878	04044	05180	06287	16
45	95157	96546	97893	99199	8·00467	01699	02898	04063	05199	06305	15
46	95180	96569	97915	99221	8·00488	01720	02917	04083	05218	06324	14
47	95204	96592	97937	99242	8·00509	01740	02937	04102	05236	06342	13
48	95227	96615	97959	99264	8·00530	01760	02957	04121	05255	06360	12
49	95251	96637	97981	99285	8·00551	01780	02976	04140	05274	06378	11
50	95274	96660	98003	99306	8·00571	01801	02996	04159	05292	06396	10
51	95298	96683	98025	99328	8·00592	01821	03016	04178	05311	06414	9
52	95321	96706	98048	99349	8·00613	01841	03035	04197	05329	06433	8
53	95344	96728	98070	99371	8·00634	01861	03055	04217	05348	06451	7
54	95368	96751	98092	99392	8·00654	01881	03074	04236	05367	06469	6
55	95391	96774	98114	99413	8·00675	01901	03094	04255	05385	06487	5
56	95415	96796	98136	99435	8·00696	01922	03114	04274	05404	06505	4
57	95438	96819	98157	99456	8·00717	01942	03133	04293	05422	06523	3
58	95461	96842	98179	99477	8·00737	01962	03153	04312	05441	06541	2
59	95485	96864	98201	99498	8·00758	01982	03172	04331	05460	06560	1
60	95508	96887	98223	99520	8·00779	02002	03192	04350	05478	06578	0
″	89° 29′	89° 28′	89° 27′	89° 26′	89° 25′	89° 24′	89° 23′	89° 22′	89° 21′	89° 20′	″

Cosine

LOG. SINES OF SMALL ARCS TO EACH SECOND

″	0° 40′	0° 41′	0° 42′	0° 43′	0° 44′	0° 45′	0° 46′	0° 47′	0° 48′	0° 49′	″
	8·	8·	8·	8·	8·	8·	8·	8·	8·	8·	
0	06578	07650	08696	09718	10717	11693	12647	13581	14495	15391	60
1	06596	07668	08714	09735	10733	11709	12663	13596	14510	15406	59
2	06614	07685	08731	09752	10750	11725	12679	13612	14525	15420	58
3	06632	07703	08748	09769	10766	11741	12694	13627	14541	15435	57
4	06650	07721	08765	09786	10782	11757	12710	13643	14556	15450	56
5	06668	07738	08783	09802	10799	11773	12726	13658	14571	15465	55
6	06686	07756	08800	09819	10815	11789	12741	13673	14586	15479	54
7	06704	07773	08817	09836	10832	11805	12757	13689	14601	15494	53
8	06722	07791	08834	09853	10848	11821	12773	13704	14616	15509	52
9	06740	07809	08851	09870	10864	11837	12788	13719	14631	15523	51
10	06758	07826	08868	09886	10881	11853	12804	13735	14646	15538	50
11	06776	07844	08886	09903	10897	11869	12820	13750	14661	15553	49
12	06794	07861	08903	09920	10914	11885	12835	13765	14676	15568	48
13	06812	07879	08920	09937	10930	11901	12851	13781	14691	15582	47
14	06830	07896	08937	09953	10946	11917	12867	13796	14706	15597	46
15	06848	07914	08954	09970	10963	11933	12882	13811	14721	15612	45
16	06866	07932	08971	09987	10979	11949	12898	13827	14736	15626	44
17	06884	07949	08988	10004	10995	11965	12914	13842	14751	15641	43
18	06902	07967	09006	10020	11012	11981	12929	13857	14766	15656	42
19	06920	07984	09023	10037	11028	11997	12945	13873	14781	15670	41
20	06938	08002	09040	10054	11044	12013	12961	13888	14796	15685	40
21	06956	08019	09057	10070	11061	12029	12976	13903	14811	15700	39
22	06974	08037	09074	10087	11077	12045	12992	13919	14826	15714	38
23	06992	08054	09091	10104	11093	12061	13007	13934	14841	15729	37
24	07010	08072	09108	10120	11110	12077	13023	13949	14856	15744	36
25	07028	08089	09125	10137	11126	12093	13039	13964	14871	15758	35
26	07046	08107	09142	10154	11142	12109	13054	13980	14886	15773	34
27	07063	08124	09159	10170	11159	12125	13070	13995	14901	15788	33
28	07081	08141	09176	10187	11175	12141	13085	14010	14915	15802	32
29	07099	08159	09193	10204	11191	12157	13101	14025	14930	15817	31
30	07117	08176	09210	10220	11207	12172	13117	14041	14945	15832	30
31	07135	08194	09227	10237	11224	12188	13132	14056	14960	15846	29
32	07153	08211	09244	10254	11240	12204	13148	14071	14975	15861	28
33	07171	08229	09261	10270	11256	12220	13163	14086	14990	15875	27
34	07189	08246	09278	10287	11272	12236	13179	14101	15005	15890	26
35	07206	08263	09295	10303	11289	12252	13194	14117	15020	15905	25
36	07224	08281	09312	10320	11305	12268	13210	14132	15035	15919	24
37	07242	08298	09329	10337	11321	12284	13225	14147	15050	15934	23
38	07260	08316	09346	10353	11337	12300	13241	14162	15065	15948	22
39	07278	08333	09363	10370	11354	12315	13256	14178	15079	15963	21
40	07295	08350	09380	10386	11370	12331	13272	14193	15094	15978	20
41	07313	08368	09397	10403	11386	12347	13287	14208	15109	15992	19
42	07331	08385	09414	10420	11402	12363	13303	14223	15124	16007	18
43	07349	08403	09431	10436	11418	12379	13318	14238	15139	16021	17
44	07367	08420	09448	10453	11435	12395	13334	14253	15154	16036	16
45	07384	08437	09465	10469	11451	12410	13349	14269	15169	16050	15
46	07402	08455	09482	10486	11467	12426	13365	14284	15183	16065	14
47	07420	08472	09499	10502	11483	12442	13380	14299	15198	16079	13
48	07438	08489	09516	10519	11499	12458	13396	14314	15213	16094	12
49	07455	08506	09533	10535	11515	12474	13411	14329	15228	16109	11
50	07473	08524	09550	10552	11531	12489	13427	14344	15243	16123	10
51	07491	08541	09567	10568	11548	12505	13442	14359	15258	16138	9
52	07509	08558	09583	10585	11564	12521	13458	14375	15272	16152	8
53	07526	08576	09600	10601	11580	12537	13473	14390	15287	16167	7
54	07544	08593	09617	10618	11596	12553	13489	14405	15302	16181	6
55	07562	08610	09634	10634	11612	12568	13504	14420	15317	16196	5
56	07579	08627	09651	10651	11628	12584	13519	14435	15332	16210	4
57	07597	08645	09668	10667	11644	12600	13535	14450	15346	16225	3
58	07615	08662	09685	10684	11660	12616	13550	14465	15361	16239	2
59	07632	08679	09701	10700	11677	12631	13566	14480	15376	16254	1
60	07650	08696	09718	10717	11693	12647	13581	14495	15391	16268	0
″	89° 19′	89° 18′	89° 17′	89° 16′	89° 15′	89° 14′	89° 13′	89° 12′	89° 11′	89° 10′	″

COSINE

LOG. SINES OF SMALL ARCS TO EACH SECOND

″	0° 50′	0° 51′	0° 52′	0° 53′	0° 54′	0° 55′	0° 56′	0° 57′	0° 58′	0° 59′	″
	8·	8·	8·	8·	8·	8·	8·	8·	8·	8·	
0	16268	17128	17971	18798	19610	20407	21189	21958	22713	23456	60
1	16283	17142	17985	18812	19624	20420	21202	21971	22726	23468	59
2	16297	17156	17999	18826	19637	20433	21215	21983	22738	23480	58
3	16311	17171	18013	18839	19650	20446	21228	21996	22751	23492	57
4	16326	17185	18027	18853	19664	20460	21241	22009	22763	23505	56
5	16340	17199	18041	18867	19677	20473	21254	22022	22776	23517	55
6	16355	17213	18055	18880	19691	20486	21267	22034	22788	23529	54
7	16369	17227	18069	18894	19704	20499	21280	22047	22801	23541	53
8	16384	17241	18082	18908	19717	20512	21293	22060	22813	23554	52
9	16398	17256	18096	18921	19731	20525	21306	22072	22826	23566	51
10	16413	17270	18110	18935	19744	20538	21319	22085	22838	23578	50
11	16427	17284	18124	18948	19757	20552	21331	22098	22850	23590	49
12	16441	17298	18138	18962	19771	20565	21344	22110	22863	23603	48
13	16456	17312	18152	18976	19784	20578	21357	22123	22875	23615	47
14	16470	17326	18166	18989	19797	20591	21370	22136	22888	23627	46
15	16485	17340	18180	19003	19811	20604	21383	22148	22900	23639	45
16	16499	17355	18193	19016	19824	20617	21396	22161	22913	23652	44
17	16513	17369	18207	19030	19837	20630	21409	22173	22925	23664	43
18	16528	17383	18221	19044	19851	20643	21422	22186	22937	23676	42
19	16542	17397	18235	19057	19864	20656	21434	22199	22950	23688	41
20	16557	17411	18249	19071	19877	20669	21447	22211	22962	23700	40
21	16571	17425	18263	19084	19891	20682	21460	22224	22975	23713	39
22	16585	17439	18276	19098	19904	20696	21473	22237	22987	23725	38
23	16600	17453	18290	19111	19917	20709	21486	22249	22999	23737	37
24	16614	17467	18304	19125	19931	20722	21499	22262	23012	23749	36
25	16628	17481	18318	19139	19944	20735	21511	22274	23024	23761	35
26	16643	17495	18332	19152	19957	20748	21524	22287	23037	23773	34
27	16657	17510	18345	19166	19971	20761	21537	22300	23049	23786	33
28	16672	17524	18359	19179	19984	20774	21550	22312	23061	23798	32
29	16686	17538	18373	19193	19997	20787	21563	22325	23074	23810	31
30	16700	17552	18387	19206	20010	20800	21576	22337	23086	23822	30
31	16715	17566	18401	19220	20024	20813	21588	22350	23098	23834	29
32	16729	17580	18414	19233	20037	20826	21601	22363	23111	23846	28
33	16743	17594	18428	19247	20050	20839	21614	22375	23123	23859	27
34	16757	17608	18442	19260	20064	20852	21627	22388	23136	23871	26
35	16772	17622	18456	19274	20077	20865	21640	22400	23148	23883	25
36	16786	17636	18469	19287	20090	20878	21652	22413	23160	23895	24
37	16800	17650	18483	19301	20103	20891	21665	22425	23173	23907	23
38	16815	17664	18497	19314	20117	20904	21678	22438	23185	23919	22
39	16829	17678	18511	19328	20130	20917	21691	22451	23197	23931	21
40	16843	17692	18524	19341	20143	20930	21703	22463	23210	23944	20
41	16858	17706	18538	19355	20156	20943	21716	22476	23222	23956	19
42	16872	17720	18552	19368	20170	20956	21729	22488	23234	23968	18
43	16886	17734	18566	19382	20183	20969	21742	22501	23247	23980	17
44	16900	17748	18579	19395	20196	20982	21754	22513	23259	23992	16
45	16915	17762	18593	19409	20209	20995	21767	22526	23271	24004	15
46	16929	17776	18607	19422	20222	21008	21780	22538	23284	24016	14
47	16943	17790	18621	19436	20236	21021	21793	22551	23296	24028	13
48	16957	17804	18634	19449	20249	21034	21805	22563	23308	24041	12
49	16972	17818	18648	19463	20262	21047	21818	22576	23321	24053	11
50	16986	17832	18662	19476	20275	21060	21831	22588	23333	24065	10
51	17000	17846	18675	19489	20288	21073	21844	22601	23345	24077	9
52	17014	17860	18689	19503	20302	21086	21856	22613	23357	24089	8
53	17029	17874	18703	19516	20315	21099	21869	22626	23370	24101	7
54	17043	17888	18716	19530	20328	21112	21882	22638	23382	24113	6
55	17057	17902	18730	19543	20341	21125	21895	22651	23394	24125	5
56	17071	17916	18744	19557	20354	21138	21907	22663	23407	24137	4
57	17085	17930	18757	19570	20368	21151	21920	22676	23419	24149	3
58	17100	17943	18771	19583	20381	21164	21933	22688	23431	24161	2
59	17114	17957	18785	19597	20394	21177	21945	22701	23443	24173	1
60	17128	17971	18798	19610	20407	21189	21958	22713	23456	24186	0
″	89° 9′	89° 8′	89° 7′	89° 6′	89° 5′	89° 4′	89° 3′	89° 2′	89° 1′	89° 0′	″

Cosine

LOG. SINES OF SMALL ARCS TO EACH SECOND

″	1° 0′	1° 1′	1° 2′	1° 3′	1° 4′	1° 5′	1° 6′	1° 7′	1° 8′	1° 9′	″
	8·	8·	8·	8·	8·	8·	8·	8·	8·	8·	
0	241855	249033	256094	263042	269881	276614	283243	289773	296207	302546	60
1	241976	249152	256211	263157	269994	276725	283353	289881	296313	302651	59
2	242097	249270	256328	263272	270107	276836	283463	289989	296420	302756	58
3	242217	249389	256444	263387	270220	276948	283572	290097	296526	302861	57
4	242338	249507	256561	263502	270333	277059	283682	290205	296632	302965	56
5	242458	249626	256678	263616	270446	277170	283791	290313	296739	303070	55
6	242578	249744	256794	263731	270559	277281	283901	290421	296845	303175	54
7	242699	249863	256911	263846	270672	277392	284010	290529	296951	303280	53
8	242819	249981	257027	263960	270785	277503	284120	290637	297057	303384	52
9	242940	250100	257144	264075	270898	277615	284229	290745	297164	303489	51
10	243060	250218	257260	264190	271010	277726	284339	290852	297270	303594	50
11	243180	250336	257376	264304	271123	277837	284448	290960	297376	303698	49
12	243300	250455	257493	264419	271236	277948	284557	291068	297482	303803	48
13	243421	250573	257609	264533	271349	278059	284667	291175	297588	303907	47
14	243541	250691	257725	264648	271461	278170	284776	291283	297694	304012	46
15	243661	250809	257842	264762	271574	278281	284885	291391	297800	304117	45
16	243781	250927	257958	264877	271687	278391	284994	291498	297906	304221	44
17	243901	251045	258074	264991	271799	278502	285104	291606	298012	304325	43
18	244021	251164	258190	265105	271912	278613	285213	291713	298118	304430	42
19	244141	251282	258307	265220	272024	278724	285322	291821	298224	304534	41
20	244261	251400	258423	265334	272137	278835	285431	291928	298330	304639	40
21	244381	251518	258539	265448	272249	278946	285540	292036	298436	304743	39
22	244501	251636	258655	265562	272362	279056	285649	292143	298542	304847	38
23	244621	251754	258771	265677	272474	279167	285758	292251	298648	304952	37
24	244741	251871	258887	265791	272587	279278	285867	292358	298754	305056	36
25	244861	251989	259003	265905	272699	279388	285976	292466	298859	305160	35
26	244980	252107	259119	266019	272811	279499	286085	292573	298965	305265	34
27	245100	252225	259235	266133	272924	279610	286194	292680	299071	305369	33
28	245220	252343	259351	266247	273036	279720	286303	292787	299177	305473	32
29	245339	252460	259466	266361	273148	279831	286412	292895	299282	305577	31
30	245459	252578	259582	266475	273260	279941	286521	293002	299388	305681	30
31	245579	252696	259698	266589	273373	280052	286629	293109	299494	305785	29
32	245698	252813	259814	266703	273485	280162	286738	293216	299599	305890	28
33	245818	252931	259929	266817	273597	280272	286847	293324	299705	305994	27
34	245937	253049	260045	266931	273709	280383	286956	293431	299810	306098	26
35	246057	253166	260161	267045	273821	280493	287064	293538	299916	306202	25
36	246176	253284	260276	267158	273933	280604	287173	293645	300021	306306	24
37	246296	253401	260392	267272	274045	280714	287282	293752	300127	306410	23
38	246415	253519	260508	267386	274157	280824	287390	293859	300232	306514	22
39	246534	253636	260623	267500	274269	280934	287499	293966	300338	306618	21
40	246654	253753	260739	267613	274381	281045	287608	294073	300443	306721	20
41	246773	253871	260854	267727	274493	281155	287716	294180	300549	306825	19
42	246892	253988	260970	267841	274605	281265	287825	294287	300654	306929	18
43	247011	254105	261085	267954	274717	281375	287933	294394	300759	307033	17
44	247131	254223	261200	268068	274828	281485	288042	294500	300865	307137	16
45	247250	254340	261316	268181	274940	281595	288150	294607	300970	307241	15
46	247369	254457	261431	268295	275052	281705	288259	294714	301075	307344	14
47	247488	254574	261546	268408	275164	281815	288367	294821	301180	307448	13
48	247607	254691	261662	268522	275275	281925	288475	294928	301286	307552	12
49	247726	254808	261777	268635	275387	282035	288584	295034	301391	307655	11
50	247845	254925	261892	268749	275499	282145	288692	295141	301496	307759	10
51	247964	255042	262007	268862	275610	282255	288800	295248	301601	307863	9
52	248083	255159	262122	268975	275722	282365	288908	295354	301706	307966	8
53	248202	255276	262237	269089	275833	282475	289017	295461	301811	308070	7
54	248321	255393	262353	269202	275945	282585	289125	295568	301916	308173	6
55	248440	255510	262468	269315	276057	282695	289233	295674	302021	308277	5
56	248558	255627	262583	269428	276168	282805	289341	295781	302126	308380	4
57	248677	255744	262698	269542	276279	282914	289449	295887	302231	308484	3
58	248796	255861	262813	269655	276391	283024	289557	295994	302336	308587	2
59	248914	255978	262927	269768	276502	283134	289665	296100	302441	308691	1
60	249033	256094	263042	269881	276614	283243	289773	296207	302546	308794	0
″	88° 59′	88° 58′	88° 57′	88° 56′	88° 55′	88° 54′	88° 53′	88° 52′	88° 51′	88° 50′	″

COSINE

LOG. SINES OF SMALL ARCS TO EACH SECOND

″	1° 10′	1° 11′	1° 12′	1° 13′	1° 14′	1° 15′	1° 16′	1° 17′	1° 18′	1° 19′	″
	8·	8·	8·	8·	8·	8·	8·	8·	8·	8·	
0	308794	314954	321027	327016	332924	338753	344504	350181	355783	361315	60
1	308898	315056	321127	327115	333022	338849	344600	350275	355876	361407	59
2	309001	315157	321228	327215	333120	338946	344695	350368	355969	361498	58
3	309104	315259	321328	327314	333218	339042	344790	350462	356062	361590	57
4	309208	315361	321429	327413	333315	339139	344885	350556	356154	361681	56
5	309311	315463	321529	327512	333413	339235	344980	350650	356247	361773	55
6	309414	315565	321630	327611	333511	339332	345075	350744	356340	361864	54
7	309517	315667	321730	327710	333608	339428	345170	350838	356432	361956	53
8	309620	315768	321830	327809	333706	339524	345265	350932	356525	362047	52
9	309724	315870	321931	327908	333804	339621	345361	351026	356618	362139	51
10	309827	315972	322031	328007	333901	339717	345456	351119	356710	362230	50
11	309930	316073	322131	328106	333999	339813	345551	351213	356803	362321	49
12	310033	316175	322231	328204	334096	339909	345646	351307	356895	362413	48
13	310136	316277	322332	328303	334194	340006	345740	351401	356988	362504	47
14	310239	316378	322432	328402	334291	340102	345835	351494	357080	362596	46
15	310342	316480	322532	328501	334389	340198	345930	351588	357173	362687	45
16	310445	316581	322632	328600	334486	340294	346025	351682	357265	362778	44
17	310548	316683	322732	328698	334584	340390	346120	351775	357358	362870	43
18	310651	316785	322832	328797	334681	340486	346215	351869	357450	362961	42
19	310754	316886	322932	328896	334779	340582	346310	351963	357543	363052	41
20	310857	316987	323033	328995	334876	340679	346405	352056	357635	363143	40
21	310960	317089	323133	329093	334973	340775	346499	352150	357728	363234	39
22	311063	317190	323233	329192	335071	340871	346594	352243	357820	363326	38
23	311166	317292	323333	329291	335168	340967	346689	352337	357912	363417	37
24	311268	317393	323433	329389	335265	341063	346784	352430	358005	363508	36
25	311371	317494	323533	329488	335362	341159	346878	352524	358097	363599	35
26	311474	317596	323632	329586	335460	341255	346973	352617	358189	363690	34
27	311577	317697	323732	329685	335557	341350	347068	352711	358281	363781	33
28	311679	317798	323832	329783	335654	341446	347162	352804	358374	363872	32
29	311782	317900	323932	329882	335751	341542	347257	352898	358466	363963	31
30	311885	318001	324032	329980	335848	341638	347352	352991	358558	364055	30
31	311987	318102	324132	330079	335946	341734	347446	353084	358650	364146	29
32	312090	318203	324232	330177	336043	341830	347541	353178	358742	364237	28
33	312193	318304	324331	330276	336140	341926	347635	353271	358835	364328	27
34	312295	318406	324431	330374	336237	342021	347730	353364	358927	364419	26
35	312398	318507	324531	330472	336334	342117	347824	353458	359019	364509	25
36	312500	318608	324630	330571	336431	342213	347919	353551	359111	364600	24
37	312603	318709	324730	330669	336528	342309	348013	353644	359203	364691	23
38	312705	318810	324830	330767	336625	342404	348108	353737	359295	364782	22
39	312808	318911	324929	330866	336722	342500	348202	353831	359387	364873	21
40	312910	319012	325029	330964	336819	342596	348297	353924	359479	364964	20
41	313013	319113	325129	331062	336916	342691	348391	354017	359571	365055	19
42	313115	319214	325228	331160	337013	342787	348485	354110	359663	365146	18
43	313217	319315	325328	331259	337109	342882	348580	354203	359755	365236	17
44	313320	319416	325427	331357	337206	342978	348674	354296	359847	365327	16
45	313422	319516	325527	331455	337303	343074	348768	354389	359939	365418	15
46	313524	319617	325626	331553	337400	343169	348863	354483	360031	365509	14
47	313626	319718	325726	331651	337497	343265	348957	354576	360122	365599	13
48	313729	319819	325825	331749	337593	343360	349051	354669	360214	365690	12
49	313831	319920	325924	331847	337690	343456	349145	354762	360306	365781	11
50	313933	320021	326024	331945	337787	343551	349240	354855	360398	365871	10
51	314035	320121	326123	332043	337884	343646	349334	354948	360490	365962	9
52	314137	320222	326223	332141	337980	343742	349428	355041	360582	366053	8
53	314239	320323	326322	332239	338077	343837	349522	355133	360673	366143	7
54	314342	320423	326421	332337	338174	343933	349616	355226	360765	366234	6
55	314444	320524	326520	332435	338270	344028	349710	355319	360857	366324	5
56	314546	320625	326620	332533	338367	344123	349804	355412	360948	366415	4
57	314648	320725	326719	332631	338463	344219	349898	355505	361040	366505	3
58	314750	320826	326818	332729	338560	344314	349993	355598	361132	366596	2
59	314852	320926	326917	332826	338656	344409	350087	355691	361223	366686	1
60	314954	321027	327016	332924	338753	344504	350181	355783	361315	366[illegible]	0
″	88° 49′	88° 48′	88° 47′	88° 46′	88° 45′	88° 44′	88° 43′	88° 42′	88° 41′	88° 40′	″

Cosine

LOG. SINES OF SMALL ARCS TO EACH SECOND

″	1° 20′	1° 21′	1° 22′	1° 23′	1° 24′	1° 25′	1° 26′	1° 27′	1° 28′	1° 29′	″
	8·	8·	8·	8·	8·	8·	8·	8·	8·	8·	
0	366777	372171	377499	382762	387962	393101	398179	403199	408161	413068	60
1	366867	372260	377587	382849	388048	393186	398263	403282	408244	413149	59
2	366958	372350	377675	382936	388134	393271	398348	403365	408326	413230	58
3	367048	372439	377763	383024	388221	393356	398432	403448	408408	413311	57
4	367139	372528	377852	383111	388307	393441	398516	403532	408490	413393	56
5	367229	372617	377940	383198	388393	393526	398600	403615	408572	413474	55
6	367319	372707	378028	383285	388479	393611	398684	403698	408654	413555	54
7	367410	372796	378116	383372	388565	393696	398768	403781	408737	413636	53
8	367500	372885	378204	383459	388651	393781	398852	403864	408819	413718	52
9	367590	372974	378292	383546	388737	393866	398936	403947	408901	413799	51
10	367681	373063	378380	383633	388823	393951	399020	404030	408983	413880	50
11	367771	373153	378469	383720	388909	394036	399104	404113	409065	413961	49
12	367861	373242	378557	383807	388995	394121	399188	404196	409147	414042	48
13	367951	373331	378645	383894	389081	394206	399272	404279	409229	414123	47
14	368042	373420	378733	383981	389167	394291	399356	404362	409311	414204	46
15	368132	373509	378821	384068	389253	394376	399440	404445	409393	414286	45
16	368222	373598	378909	384155	389338	394461	399524	404528	409475	414367	44
17	368312	373687	378997	384242	389424	394546	399607	404611	409557	414448	43
18	368402	373776	379084	384329	389510	394631	399691	404694	409639	414529	42
19	368492	373865	379172	384415	389596	394715	399775	404777	409721	414610	41
20	368582	373954	379260	384502	389682	394800	399859	404859	409803	414691	40
21	368672	374043	379348	384589	389768	394885	399943	404942	409885	414772	39
22	368763	374132	379436	384676	389853	394970	400027	405025	409967	414853	38
23	368853	374221	379524	384763	389939	395055	400110	405108	410049	414934	37
24	368943	374310	379612	384850	390025	395139	400194	405191	410131	415015	36
25	369033	374399	379700	384936	390111	395224	400278	405274	410212	415096	35
26	369123	374488	379787	385023	390196	395309	400362	405356	410294	415177	34
27	369213	374577	379875	385110	390282	395393	400445	405439	410376	415257	33
28	369302	374665	379963	385197	390368	395478	400529	405522	410458	415338	32
29	369392	374754	380051	385283	390453	395563	400613	405605	410540	415419	31
30	369482	374843	380138	385370	390539	395647	400696	405687	410621	415500	30
31	369572	374932	380226	385457	390625	395732	400780	405770	410703	415581	29
32	369662	375021	380314	385543	390710	395817	400864	405853	410785	415662	28
33	369752	375109	380401	385630	390796	395901	400947	405935	410867	415743	27
34	369842	375198	380489	385716	390882	395986	401031	406018	410948	415823	26
35	369932	375287	380577	385803	390967	396070	401115	406101	411030	415904	25
36	370021	375375	380664	385890	391053	396155	401198	406183	411112	415985	24
37	370111	375464	380752	385976	391138	396240	401282	406266	411193	416066	23
38	370201	375553	380840	386063	391224	396324	401365	406348	411275	416146	22
39	370291	375641	380927	386149	391309	396409	401449	406431	411357	416227	21
40	370380	375730	381015	386236	391395	396493	401532	406514	411438	416308	20
41	370470	375819	381102	386322	391480	396578	401616	406596	411520	416389	19
42	370560	375907	381190	386409	391566	396662	401699	406679	411602	416469	18
43	370649	375996	381277	386495	391651	396746	401783	406761	411683	416550	17
44	370739	376084	381365	386582	391736	396831	401866	406844	411765	416631	16
45	370829	376173	381452	386668	391822	396915	401950	406926	411846	416711	15
46	370918	376261	381540	386754	391907	397000	402033	407009	411928	416792	14
47	371008	376350	381627	386841	391993	397084	402116	407091	412009	416872	13
48	371097	376438	381714	386927	392078	397168	402200	407173	412091	416953	12
49	371187	376527	381802	387013	392163	397253	402283	407256	412172	417034	11
50	371277	376615	381889	387100	392249	397337	402366	407338	412254	417114	10
51	371366	376704	381977	387186	392334	397421	402450	407421	412335	417195	9
52	371456	376792	382064	387272	392419	397506	402533	407503	412417	417275	8
53	371545	376881	382151	387359	392504	397590	402616	407585	412498	417356	7
54	371635	376969	382239	387445	392590	397674	402700	407668	412579	417436	6
55	371724	377057	382326	387531	392675	397758	402783	407750	412661	417517	5
56	371813	377146	382413	387617	392760	397843	402866	407832	412742	417597	4
57	371903	377234	382500	387704	392845	397927	402949	407915	412824	417678	3
58	371992	377322	382588	387790	392930	398011	403033	407997	412905	417758	2
59	372082	377411	382675	387876	393016	398095	403116	408079	412986	417839	1
60	372171	377499	382762	387962	393101	398179	403199	408161	413068	4179·9	0
″	88° 39′	88° 38′	88° 37′	88° 36′	88° 35′	88° 34′	88° 33′	88° 32′	88° 31′	88° 30′	″

Cosine

LOG. SINES OF SMALL ARCS TO TEN SECONDS

° ′	0″	10″	20″	30″	40″	50″	60″	Parts	° ′
	8·	8·	8·	8·	8·	8·	8·		
1 30	417919	418722	419524	420325	421123	421921	422717	32′ 37′	88 29
1 31	422717	423511	424304	425096	425886	426675	427462	1″ 78 74	88 28
1 32	427462	428248	429032	429815	430597	431377	432156	2 156 148	88 27
1 33	432156	432934	433710	434484	435257	436029	436800	3 235 223	88 26
1 34	436800	437569	438337	439103	439868	440632	441394	4 313 297	88 25
1 35	441394	442156	442915	443674	444431	445186	445941	5 391 371	88 24
1 36	445941	446694	447446	448196	448946	449694	450440	6 469 445	88 23
1 37	450440	451186	451930	452673	453414	454154	454893	7 547 519	88 22
1 38	454893	455631	456368	457103	457837	458570	459301	8 626 594	88 21
1 39	459301	460032	460761	461489	462215	462941	463665	9 704 668	88 20
1 40	463665	464388	465110	465830	466550	467268	467985	42′ 47′	88 19
1 41	467985	468701	469416	470129	470841	471553	472263	1′ 71 67	88 18
1 42	472263	472971	473679	474386	475091	475795	476498	2 141 135	88 17
1 43	476498	477200	477901	478601	479299	479997	480693	3 212 202	88 16
1 44	480693	481388	482083	482776	483467	484158	484848	4 282 269	88 15
1 45	484848	485536	486224	486910	487596	488280	488963	5 353 336	88 14
1 46	488963	489645	490326	491006	491685	492363	493040	6 424 404	88 13
1 47	493040	493715	494390	495064	495736	496408	497078	7 494 471	88 12
1 48	497078	497748	498416	499084	499750	500416	501080	8 565 538	88 11
1 49	501080	501743	502405	503067	503727	504386	505045	9 635 606	88 10
1 50	505045	505702	506358	507014	507668	508321	508974	52′ 57′	88 9
1 51	508974	509625	510275	510925	511573	512221	512867	1″ 64 62	88 8
1 52	512867	513513	514157	514801	515444	516086	516726	2 129 123	88 7
1 53	516726	517366	518005	518643	519280	519916	520551	3 193 185	88 6
1 54	520551	521186	521819	522451	523083	523713	524343	4 257 246	88 5
1 55	524343	524972	525599	526226	526852	527477	528102	5 321 308	88 4
1 56	528102	528725	529347	529969	530590	531209	531828	6 386 370	88 3
1 57	531828	532446	533063	533679	534295	534909	535523	7 450 431	88 2
1 58	535523	536136	536747	537358	537969	538578	539186	8 514 493	88 1
1 59	539186	539794	540401	541007	541612	542216	542819	9 579 554	88 0
2 0	542819	543422	544023	544624	545224	545823	546422	2′ 7′	87 59
2 1	546422	547019	547616	548212	548807	549401	549995	1″ 59 57	87 58
2 2	549995	550587	551179	551770	552361	552950	553539	2 118 113	87 57
2 3	553539	554126	554713	555300	555885	556470	557054	3 177 170	87 56
2 4	557054	557637	558219	558801	559381	559961	560540	4 236 227	87 55
2 5	560540	561119	561696	562273	562849	563425	563999	5 295 284	87 54
2 6	563999	564573	565146	565719	566290	566861	567431	6 355 340	87 53
2 7	567431	568000	568569	569137	569704	570270	570836	7 414 397	87 52
2 8	570836	571401	571965	572528	573091	573653	574214	8 473 454	87 51
2 9	574214	574774	575334	575893	576451	577009	577566	9 532 510	87 50
2 10	577566	578122	578678	579232	579786	580340	580892	12′ 17′	87 49
2 11	580892	581444	581995	582546	583096	583645	584193	1″ 55 53	87 48
2 12	584193	584741	585288	585834	586380	586925	587469	2 109 105	87 47
2 13	587469	588013	588556	589098	589640	590181	590721	3 164 158	87 46
2 14	590721	591260	591799	592338	592875	593412	593948	4 218 210	87 45
2 15	593948	594484	595019	595553	596086	596619	597152	5 273 263	87 44
2 16	597152	597683	598214	598745	599274	599803	600332	6 328 316	87 43
2 17	600332	600859	601387	601913	602439	602964	603489	7 382 368	87 42
2 18	603489	604012	604536	605058	605580	606102	606623	8 437 421	87 41
2 19	606623	607143	607662	608181	608699	609217	609734	9 491 473	87 40
2 20	609734	610251	610766	611282	611796	612310	612823	22′ 27′	87 39
2 21	612823	613336	613848	614360	614871	615381	615891	1′ 51 49	87 38
2 22	615891	616400	616909	617417	617924	618431	618937	2 102 98	87 37
2 23	618937	619442	619947	620452	620956	621459	621962	3 152 147	87 36
2 24	621962	622464	622965	623466	623966	624466	624965	4 203 196	87 35
2 25	624965	625464	625962	626459	626956	627453	627948	5 254 245	87 34
2 26	627948	628444	628938	629432	629926	630419	630911	6 305 294	87 33
2 27	630911	631403	631894	632385	632875	633365	633854	7 356 343	87 32
2 28	633854	634342	634830	635317	635804	636291	636776	8 406 392	87 31
2 29	636776	637262	637746	638230	638714	639197	639680	9 457 441	87 30
2 30	639680	640162	640643	641124	641604	642084	642563		87 29
° ′	60″	50″	40″	30″	20″	10″	0″	Parts	° ′

Cosine

LOG. SINES OF SMALL ARCS TO TEN SECONDS

° ′	0″	10″	20″	30″	40″	50″	60″	Parts			° ′
	8	8·	8·	8·	8·	8·	8·				
2 30	039680	640162	640643	641124	641604	642084	642563		32′	37′	87 29
2 31	642563	643042	643520	643998	644475	644952	645428	1″	47	46	87 28
2 32	645428	645904	646379	646854	647328	647801	648274	2	95	92	87 27
2 33	648274	648747	649219	649690	650161	650632	651102	3	142	138	87 26
2 34	651102	651571	652040	652508	652976	653444	653911	4	190	184	87 25
2 35	653911	654377	654843	655308	655773	656238	656702	5	237	229	87 24
2 36	656702	657165	657628	658090	658552	659014	659475	6	284	275	87 23
2 37	659475	659935	660395	660855	661314	661772	662230	7	332	321	87 22
2 38	662230	662688	663145	663602	664058	664513	664968	8	379	367	87 21
2 39	664968	665423	665877	666331	666784	667237	667689	9	427	413	87 20
2 40	667689	668141	668592	669043	669494	669944	670393		42′	47′	87 19
2 41	670393	670842	671291	671739	672187	672634	673080	1″	45	43	87 18
2 42	673080	673527	673972	674418	674863	675307	675751	2	89	86	87 17
2 43	675751	676194	676638	677080	677522	677964	678405	3	133	130	87 16
2 44	678405	678846	679286	679726	680166	680605	681043	4	178	173	87 15
2 45	681043	681481	681919	682356	682793	683230	683665	5	223	216	87 14
2 46	683665	684101	684536	684971	685405	685838	686272	6	267	259	87 13
2 47	686272	686705	687137	687569	688001	688432	688863	7	312	302	87 12
2 48	688863	689293	689723	690152	690581	691010	691438	8	356	346	87 11
2 49	691438	691866	692293	692720	693146	693572	693998	9	400	389	87 10
2 50	693998	694423	694848	695272	695696	696120	696543		52′	57′	87 9
2 51	696543	696966	697388	697810	698232	698653	699073	1″	42	41	87 8
2 52	699073	699494	699913	700333	700752	701171	701589	2	84	82	87 7
2 53	701589	702007	702424	702841	703258	703674	704090	3	126	122	87 6
2 54	704090	704505	704920	705335	705749	706163	706577	4	168	163	87 5
2 55	706577	706990	707402	707815	708226	708638	709049	5	209	204	87 4
2 56	709049	709460	709870	710280	710690	711099	711507	6	251	244	87 3
2 57	711507	711916	712324	712731	713139	713546	713952	7	293	285	87 2
2 58	713952	714358	714764	715169	715574	715979	716383	8	335	326	87 1
2 59	716383	716787	717190	717593	717996	718398	718800	9	377	366	87 0
3 0	718800	719202	719603	720004	720404	720804	721204		2′	7′	86 59
3 1	721204	721603	722002	722401	722799	723197	723595	1″	40	39	86 58
3 2	723595	723992	724389	724785	725181	725577	725972	2	79	77	86 57
3 3	725972	726367	726762	727156	727550	727943	728337	3	119	116	86 56
3 4	728337	728729	729122	729514	729906	730297	730688	4	158	154	86 55
3 5	730688	731079	731469	731859	732249	732638	733027	5	198	193	86 54
3 6	733027	733416	733804	734192	734579	734967	735354	6	238	232	86 53
3 7	735354	735740	736126	736512	736898	737283	737667	7	277	270	86 52
3 8	737667	738052	738436	738820	739203	739586	739969	8	317	309	86 51
3 9	739969	740352	740734	741115	741497	741878	742259	9	356	347	86 50
3 10	742259	742639	743019	743399	743778	744157	744536		12′	17′	86 49
3 11	744536	744914	745293	745670	746048	746425	746802	1″	38	37	86 48
3 12	746802	747178	747554	747930	748305	748680	749055	2	75	73	86 47
3 13	749055	749430	749804	750178	750551	750924	751297	3	113	110	86 46
3 14	751297	751670	752042	752414	752786	753157	753528	4	150	146	86 45
3 15	753528	753898	754269	754639	755008	755378	755747	5	188	183	86 44
3 16	755747	756116	756484	756852	757220	757587	757955	6	226	220	86 43
3 17	757955	758321	758688	759054	759420	759786	760151	7	263	256	86 42
3 18	760151	760516	760881	761245	761609	761973	762337	8	301	293	86 41
3 19	762337	762700	763063	763425	763787	764149	764511	9	338	329	86 40
3 20	764511	764872	765234	765594	765955	766315	766675		22′	27′	86 39
3 21	766675	767034	767394	767752	768111	768469	768828	1″	36	35	86 38
3 22	768828	769185	769543	769900	770257	770613	770970	2	71	70	86 37
3 23	770970	771326	771681	772037	772392	772747	773101	3	107	105	86 36
3 24	773101	773456	773810	774163	774517	774870	775223	4	143	139	86 35
3 25	775223	775575	775927	776279	776631	776982	777333	5	178	174	86 34
3 26	777333	777684	778035	778385	778735	779085	779434	6	214	209	86 33
3 27	779434	779783	780132	780480	780829	781177	781524	7	250	244	86 32
3 28	781524	781872	782219	782566	782912	783259	783605	8	286	278	86 31
3 29	783605	783951	784296	784641	784986	785331	785675	9	321	313	86 30
3 30	785675	786019	786363	786707	787050	787393	787736				86 29
° ′	60″	50″	40″	30″	20″	10″	0″	Parts			° ′

COSINE

LOG. SINES OF SMALL ARCS TO TEN SECONDS

° ′	0″	10″	20″	30″	40″	50″	60″	Parts	° ′
	8·	8·	8·	8·	8·	8·	8·		
3 30	785675	786019	786363	786707	787050	787393	787736	32′ 37′	86 29
3 31	787736	788078	788421	788762	789104	789446	789787	1″ 34 33	86 28
3 32	789787	790128	790468	790808	791149	791488	791828	2 68 66	86 27
3 33	791828	792167	792506	792845	793183	793521	793859	3 102 100	86 26
3 34	793859	794197	794534	794872	795208	795545	795881	4 136 133	86 25
3 35	795881	796218	796553	796889	797224	797559	797894	5 170 166	86 24
3 36	797894	798229	798563	798897	799231	799564	799897	6 204 199	86 23
3 37	799897	800230	800563	800896	801228	801560	801892	7 238 232	86 22
3 38	801892	802223	802554	802885	803216	802546	803876	8 272 266	86 21
3 39	803876	804206	804536	804866	805195	805524	805852	9 306 299	86 20
3 40	805852	806181	806509	806837	807165	807492	807819	42′ 47′	86 19
3 41	807819	808146	808473	808799	809126	809451	809777	1″ 32 32	86 18
3 42	809777	810103	810428	810753	811078	811402	811726	2 65 64	86 17
3 43	811726	812050	812374	812698	813021	813344	813667	3 97 95	86 16
3 44	813667	813989	814312	814634	814956	815277	815599	4 130 127	86 15
3 45	815599	815920	816241	816561	816882	817202	817522	5 162 159	86 14
3 46	817522	817841	818161	818480	818799	819118	819436	6 195 191	86 13
3 47	819436	819755	820073	820390	820708	821025	821343	7 228 223	86 12
3 48	821343	821659	821976	822292	822609	822925	823240	8 261 254	86 11
3 49	823240	823556	823871	824186	824501	824816	825130	9 293 286	86 10
3 50	825130	825444	825758	826072	826385	826698	827011	52′ 57′	86 9
3 51	827011	827324	827637	827949	828261	828573	828884	1″ 31 30	86 8
3 52	828884	829196	829507	829818	830129	830439	830749	2 62 61	86 7
3 53	830749	831060	831369	831679	831988	832298	832607	3 93 91	86 6
3 54	832607	832915	833224	833532	833840	834148	834456	4 124 122	86 5
3 55	834456	834763	835070	835377	835684	835991	836297	5 155 152	86 4
3 56	836297	836603	836909	837215	837520	837825	838130	6 187 182	86 3
3 57	838130	838435	838740	839044	839348	839652	839956	7 218 213	86 2
3 58	839956	840260	840563	840866	841169	841472	841774	8 249 243	86 1
3 59	841774	842076	842378	842680	842982	843283	843585	9 280 274	86 0
4 0	843585	843886	844186	844487	844787	845087	845387	2′ 7′	85 59
4 1	845387	845687	845987	846286	846585	846884	847183	1″ 30 29	85 58
4 2	847183	847481	847780	848078	848376	848673	848971	2 60 58	85 57
4 3	848971	849268	849565	849862	850159	850455	850751	3 89 88	85 56
4 4	850751	851047	851343	851639	851934	852229	852525	4 119 117	85 55
4 5	852525	852819	853114	853408	853703	853997	854291	5 149 146	85 54
4 6	854291	854584	854878	855171	855464	855757	856049	6 179 175	85 53
4 7	856049	856342	856634	856926	857218	857510	857801	7 209 204	85 52
4 8	857801	858092	858383	858674	858965	859255	859546	8 238 234	85 51
4 9	859546	859836	860126	860415	860705	860994	861283	9 268 263	85 50
4 10	861283	861572	861861	862149	862438	862726	863014	12′ 17′	85 49
4 11	863014	863302	863589	863877	864164	864451	864738	1″ 30 28	85 48
4 12	864738	865024	865311	865597	865883	866169	866455	2 57 56	85 47
4 13	866455	866740	867025	867310	867595	867880	868165	3 86 84	85 46
4 14	868165	868449	868733	869017	869301	869585	869868	4 114 112	85 45
4 15	869868	870151	870434	870717	871000	871282	871565	5 143 140	85 44
4 16	871565	871847	872129	872410	872692	872973	873255	6 172 169	85 43
4 17	873255	873536	873817	874097	874378	874658	874938	7 200 197	85 42
4 18	874938	875218	875498	875777	876057	876336	876615	8 229 225	85 41
4 19	876615	876894	877172	877451	877729	878007	878285	9 257 253	85 40
4 20	878285	878563	878841	879118	879395	879672	879949	22′ 27′	85 39
4 21	879949	880226	880503	880779	881055	881331	881607	1″ 28 27	85 38
4 22	881607	881883	882158	882433	882708	882983	883258	2 55 54	85 37
4 23	883258	883533	883807	884081	884355	884629	884903	3 82 81	85 36
4 24	884903	885177	885450	885723	885996	886269	886542	4 110 108	85 35
4 25	886542	886814	887087	887359	887631	887903	888174	5 137 135	85 34
4 26	888174	888446	888717	888988	889259	889530	889801	6 165 162	85 33
4 27	889801	890071	890341	890612	890882	891151	891421	7 192 189	85 32
4 28	891421	891690	891960	892229	892498	892767	893035	8 220 216	85 31
4 29	893035	893304	893572	893840	894108	894376	894643	9 247 243	85 30
4 30	894643	894911	895178	895445	895712	895979	896246		85 29
° ′	60″	50″	40″	30″	20″	10″	0″	Parts	° ′

Cosine

LOG. SINES, COSINES, &c.

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′ ″	m. s.	Sine	D.	Cosec.	Tangent	D.	Cotang.	Secant	D.	Cosine	m. s.	′ ″
0	0	— ∞		∞	— ∞		∞	10·000000	0	10·000000	60	60
30	2	6·162696	477121	13·837304	6·162696	477121	13·837304	10·000000	0	10·000000	58	30
1	4	6·463726	221849	13·536274	6·463726	221849	13·536274	10·000000	0	10·000000	56	59
30	6	6·639817	146128	13·360183	6·639817	146128	13·360183	10·000000	0	10·000000	54	30
2	8	6·764756	109145	13·235244	6·764756	109145	13·235244	10·000000	0	10·000000	52	58
30	10	6·861666	87150	13·138334	6·861666	87150	13·138334	10·000000	0	10·000000	50	30
3	12	6·940847	72550	13·059153	6·940847	72551	13·059153	10·000000	0	10·000000	48	57
30	14	7·007794	62148	12·992206	7·007794	62148	12·992206	10·000000	0	10·000000	46	30
4	16	7·065786	54358	12·934214	7·065786	54357	12·934214	10·000000	0	10·000000	44	56
30	18	7·116939	48305	12·883061	7·116939	48305	12·883061	10·000000	0	10·000000	42	30
5	20	7·162696	43465	12·837304	7·162696	43466	12·837304	10·000000	0	10·000000	40	55
30	22	7·204089	39509	12·795911	7·204089	39508	12·795911	10·000001	0	9·999999	38	30
6	24	7·241877	36212	12·758123	7·241878	36213	12·758122	10·000001	0	9·999999	36	54
30	26	7·276639	33424	12·723361	7·276640	33423	12·723360	10·000001	0	9·999999	34	30
7	28	7·308824	31034	12·691176	7·308825	31035	12·691175	10·000001	0	9·999999	32	53
30	30	7·338787	28963	12·661213	7·338788	28964	12·661212	10·000001	0	9·999999	30	30
8	32	7·366816	27153	12·633184	7·366817	27152	12·633183	10·000001	0	9·999999	28	52
30	34	7·393145	25554	12·606855	7·393146	25554	12·606854	10·000001	0	9·999999	26	30
9	36	7·417968	24133	12·582032	7·417970	24134	12·582030	10·000001	0	9·999999	24	51
30	38	7·441449	22863	12·558551	7·441451	22863	12·558549	10·000002	0	9·999998	22	30
10	40	7·463726	21719	12·536274	7·463727	21719	12·536273	10·000002	0	9·999998	20	50
30	42	7·484915	20685	12·515085	7·484917	20685	12·515083	10·000002	0	9·999998	18	30
11	44	7·505118	19744	12·494882	7·505120	19744	12·494880	10·000002	0	9·999998	16	49
30	46	7·524423	18885	12·475577	7·524426	18886	12·475574	10·000002	0	9·999998	14	30
12	48	7·542906	18098	12·457094	7·542909	18098	12·457091	10·000003	0	9·999997	12	48
30	50	7·560635	17374	12·439365	7·560638	17374	12·439362	10·000003	0	9·999997	10	30
13	52	7·577668	16706	12·422332	7·577672	16706	12·422328	10·000003	0	9·999997	8	47
30	54	7·594059	16087	12·405941	7·594062	16087	12·405938	10·000003	0	9·999997	6	30
14	56	7·609853	15512	12·390147	7·609857	15512	12·390143	10·000004	0	9·999996	4	46
30	58	7·625093	14977	12·374907	7·625097	14978	12·374903	10·000004	0	9·999996	2	30
15	1	7·639816	14478	12·360184	7·639820	14478	12·360180	10·000004	0	9·999996	59	45
30	2	7·654056	14010	12·345944	7·654061	14011	12·345939	10·000004	0	9·999996	58	30
16	4	7·667845	13573	12·332155	7·667849	13573	12·332151	10·000005	0	9·999995	50	44
30	6	7·681208	13161	12·318792	7·681213	13161	12·318787	10·000005	0	9·999995	54	30
17	8	7·694173	12774	12·305827	7·694179	12775	12·305821	10·000005	0	9·999995	52	43
30	10	7·706762	12410	12·293238	7·706768	12409	12·293232	10·000006	0	9·999994	50	30
18	12	7·718997	12064	12·281003	7·719003	12065	12·280997	10·000006	0	9·999994	48	42
30	14	7·730896	11738	12·269104	7·730902	11739	12·269098	10·000006	0	9·999994	46	30
19	16	7·742478	11430	12·257522	7·742484	11429	12·257516	10·000007	0	9·999993	44	41
30	18	7·753758	11136	12·246242	7·753765	11137	12·246235	10·000007	0	9·999993	42	30
20	20	7·764754	10858	12·235246	7 764761	10858	12·235239	10·000007	0	9·999993	40	40
30	22	7·775477	10593	12·224523	7·775485	10593	12·224515	10·000008	0	9·999992	38	30
21	24	7·785943	10340	12·214057	7·785951	10342	12·214049	10·000008	0	9·999992	33	39
30	26	7·796162	10100	12·203838	7·796170	10100	12·203830	10·000009	c	9·999991	34	30
22	28	7·806146	9871	12·193854	7·806155	9871	12·193845	10·000009	0	9·999991	32	38
30	30	7·815906	9651	12·184094	7·815915	9652	12·184085	10·000009	0	9·999991	30	30
23	32	7·825451	9442	12·174549	7·825460	9442	12·174540	10·000010	0	9·999990	28	37
30	34	7·834791	9240	12·165209	7·834801	9241	12·165199	10·000010	0	9·999990	26	30
24	36	7·843934	9048	12·156066	7·843944	9048	12·156056	10·000011	0	9·999989	24	36
30	38	7·852889	8864	12·147111	7·852900	8864	12·147100	10·000011	0	9·999989	22	30
25	40	7·861662	8686	12·138338	7·861674	8686	12·138326	10·000011	0	9·999989	20	35
30	42	7·870262	8515	12·129738	7·870274	8516	12·129726	10·000012	0	9·999988	18	30
26	44	7·878695	8352	12·121305	7·878708	8353	12·121292	10·000012	0	9·999988	16	34
30	46	7·886963	8195	12·113032	7·886981	8195	12·113019	10·000013	0	9·999987	14	30
27	48	7·895085	8042	12·104915	7·895099	8043	12·104901	10·000013	0	9·999987	12	33
30	50	7·903054	7896	12·096946	7·903068	7897	12·096932	10·000014	0	9·999986	10	30
28	52	7·910879	7756	12·089121	7·910894	7755	12·089106	10·000014	1	9·999986	8	32
30	54	7·918566	7619	12·081434	7·918581	7620	12·081419	10·000015	1	9·999985	6	30
29	56	7·926119	7488	12·073881	7·926134	7488	12·073866	10·000015	1	9·999985	4	31
30	58	7·933543	7361	12·066457	7·933559	7362	12·066441	10·000016	1	9·999984	2	30
30	2	7·940842	7238	12·059158	7·940858	7239	12·059142	10·000017	1	9·999983	58	30
′ ″	m. s.	Cosine	D.	Secant	Cotang.	D.	Tangent	Cosec.	D.	Sine	m. s.	′ ″

89° 5ʰ 58ᵐ

LOG. SINES, COSINES, &c.

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′ ″	m. s.	Sine	D.	Cosec.	Tangent	D.	Cotang.	Secant	D.	Cosine	m. s.	′ ″
30	0	7·940842	7238	12·059158	7·940858	7239	12·059142	10·000017		9·999983	**58**	30
30	2	7·948020	7119	12·051980	7·948037	7120	12·051963	10·000017	1	9·999983	58	30
31	4	7·955082	7005	12·044918	7·955100	7005	12·044900	10·000018	1	9·999982	56	29
30	6	7·962031	6894	12·037969	7·962049	6894	12·037951	10·000018	1	9·999982	54	30
32	8	7·968870	6785	12·031130	7·968889	6787	12·031111	10·000019	1	9·999981	52	28
30	10	7·975603	6682	12·024397	7·975622	6682	12·024378	10·000019	1	9·999981	50	30
33	12	7·982233	6580	12·017767	7·982253	6580	12·017747	10·000020	1	9·999980	48	27
30	14	7·988764	6482	12·011236	7·988785	6483	12·011215	10·000021	1	9·999979	46	30
34	16	7·995198	6387	12·004802	7·995219	6387	12·004781	10·000021	1	9·999979	44	26
30	18	8·001538	6294	11·998462	8·001560	6295	11·998440	10·000022	1	9·999978	42	30
35	20	8·007787	6204	11·992213	8·007809	6204	11·992191	10·000023	1	9·999977	40	25
30	22	8·013947	6116	11·986053	8·013970	6118	11·986030	10·000023	1	9·999977	38	30
36	24	8·020021	6032	11·979979	8·020045	6032	11·979956	10·000024	1	9·999976	36	24
30	26	8·026011	5949	11·973989	8·026035	5950	11·973965	10·000024	1	9·999976	34	30
37	28	8·031919	5869	11·968081	8·031945	5869	11·968055	10·000025	1	9·999975	32	23
30	30	8·037749	5790	11·962251	8·037775	5792	11·962225	10·000026	1	9·999974	30	30
38	32	8·043501	5715	11·956499	8·043527	5714	11·956473	10·000027	1	9·999973	28	22
30	34	8·049178	5640	11·950822	8·049205	5641	11·950795	10·000027	1	9·999973	26	30
39	36	8·054781	5567	11·945219	8·054809	5569	11·945191	10·000028	1	9·999972	24	21
30	38	8·060314	5498	11·939686	8·060342	5498	11·939658	10·000029	1	9·999971	22	30
40	40	8·065776	5428	11·934224	8·065806	5429	11·934194	10·000029	1	9·999971	20	20
30	42	8·071171	5362	11·928829	8·071201	5362	11·928799	10·000030	1	9·999970	18	30
41	44	8·076500	5296	11·923500	8·076531	5297	11·923469	10·000031	1	9·999969	16	19
30	46	8·081764	5232	11·918236	8·081795	5233	11·918205	10·000032	1	9·999968	14	30
42	48	8·086965	5170	11·913035	8·086997	5171	11·913003	10·000032	1	9·999968	12	18
30	50	8·092104	5109	11·907896	8·092137	5110	11·907863	10·000033	1	9·999967	10	30
43	52	8·097183	5050	11·902817	8·097217	5050	11·902783	10·000034	1	9·999966	8	17
30	54	8·102204	4991	11·897796	8·102239	4993	11·897761	10·000035	1	9·999965	6	30
44	56	8·107167	4935	11·892833	8·107203	4935	11·892797	10·000036	1	9·999964	4	16
30	58	8·112074	4880	11·887926	8·112110	4881	11·887890	10·000036	1	9·999964	2	30
45	**3**	8·116926	4825	11·883074	8·116963	4826	11·883037	10·000037	1	9·999963	**57**	15
30	2	8·121725	4772	11·878275	8·121763	4773	11·878237	10·000038	1	9·999962	58	30
46	4	8·126471	4721	11·873529	8·126510	4721	11·873490	10·000039	1	9·999961	56	14
30	6	8·131166	4669	11·868834	8·131206	4671	11·868794	10·000040	1	9·999960	54	30
47	8	8·135810	4620	11·864190	8·135851	4620	11·864149	10·000041	1	9·999959	52	13
30	10	8·140406	4572	11·859594	8·140447	4572	11·859553	10·000041	1	9·999959	50	30
48	12	8·144953	4523	11·855047	8·144996	4525	11·855004	10·000042	1	9·999958	48	12
30	14	8·149453	4477	11·850547	8·149497	4478	11·850503	10·000043	1	9·999957	46	30
49	16	8·153907	4431	11·846093	8·153952	4432	11·846048	10·000044	1	9·999956	44	11
30	18	8·158316	4387	11·841684	8·158361	4388	11·841639	10·000045	1	9·999955	42	30
50	20	8·162681	4343	11·837319	8·162727	4343	11·837273	10·000046	1	9·999954	40	10
30	22	8·167002	4299	11·832998	8·167049	4301	11·832951	10·000047	1	9·999953	38	30
51	24	8·171280	4258	11·828720	8·171328	4258	11·828672	10·000048	1	9·999952	36	9
30	26	8·175517	4216	11·824483	8·175566	4217	11·824434	10·000049	1	9·999951	34	30
52	28	8·179713	4176	11·820287	8·179763	4177	11·820237	10·000050	1	9·999950	32	8
30	30	8·183869	4136	11·816131	8·183919	4137	11·816081	10·000051	1	9·999949	30	30
53	32	8·187985	4096	11·812015	8·188036	4097	11·811964	10·000052	1	9·999948	28	7
30	34	8·192062	4059	11·807938	8·192115	4060	11·807885	10·000053	1	9·999947	26	30
54	36	8·196102	4021	11·803898	8·196156	4022	11·803844	10·000054	1	9·999946	24	6
30	38	8·200104	3984	11·799896	8·200159	3985	11·799841	10·000055	1	9·999945	22	30
55	40	8·204070	3948	11·795930	8·204126	3949	11·795874	10·000056	1	9·999944	20	5
30	42	8·208000	3912	11·792000	8·208057	3913	11·791943	10·000057	1	9·999943	18	30
56	44	8·211895	3877	11·788105	8·211953	3878	11·788047	10·000058	1	9·999942	16	4
30	46	8·215755	3843	11·784245	8·215814	3844	11·784186	10·000059	1	9·999941	14	30
57	48	8·219581	3810	11·780419	8·219641	3811	11·780359	10·000060	1	9·999940	12	3
30	50	8·223374	3776	11·776626	8·223434	3777	11·776566	10·000061	1	9·999939	10	30
58	52	8·227134	3743	11·772866	8·227195	3745	11·772805	10·000062	1	9·999938	8	2
30	54	8·230861	3712	11·769139	8·230924	3712	11·769076	10·000063	1	9·999937	6	30
59	56	8·234557	3680	11·765443	8·234621	3681	11·765379	10·000064	1	9·999936	4	1
30	58	8·238221	3649	11·761779	8·238286	3651	11·761714	10·000065	1	9·999935	2	30
60	**4**	8·241855	3619	11·758145	8·241921	3620	11·758079	10·000066	1	9·999934	0	0
′ ″	m. s.	Cosine	D.	Secant	Cotang.	D.	Tangent	Cosec.	D.	Sine	m. s.	′ ″

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′ ″	m. s.	Sine	D.	Cosec.	Tangent	D.	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	8·241855	3619	11·758145	8·241921	3620	11·758079	10·000066		9·999934	**56**	60
30	2	8·245459	3589	11·754541	8·245526	3590	11·754474	10·000067	1″ 0	9·999933	58	30
1	4	8·249033	3559	11·750967	8·249102	3560	11·750898	10·000068	2 0	9·999932	56	59
30	6	8·252578	3531	11·747422	8·252648	3532	11·747352	10·000069	3 0	9·999931	54	30
2	8	8·256094	3502	11·743906	8·256165	3503	11·743835	10·000071	4 0	9·999929	52	58
30	10	8·259582	3474	11·740418	8·259654	3475	11·740346	10·000072	5 0	9·999928	50	30
3	12	8·263042	3446	11·736958	8·263115	3448	11·736885	10·000073	6 0	9·999927	48	57
30	14	8·266475	3419	11·733525	8·266549	3420	11·733451	10·000074	7 0	9·999926	46	30
4	16	8·269881	3393	11·730119	8·269956	3304	11·730044	10·000075	8 0	9·999925	44	56
30	18	8·273260	3366	11·726740	8·273337	3367	11·726663	10·000076	9 0	9·999924	42	30
5	20	8·276614	3341	11·723386	8·276691	3342	11·723309	10·000078	10 0	9·999922	40	55
30	22	8·279941	3314	11·7200[illegible]	8·280020	3316	11·719980	10·000079	11 0	9·999921	38	30
6	24	8·283243	3290	11·716757	8·283323	3291	11·716677	10·000080	12 0	9·999920	36	54
30	26	8·286521	3265	11·713479	8·286602	3266	11·713398	10·000081	13 1	9·999919	34	30
7	28	8·289773	3241	11·710227	8·289856	3242	11·710144	10·000082	14 1	9·999918	32	53
30	30	8·293002	3216	11·706998	8·293086	3218	11·706914	10·000084	15 1	9·999916	30	30
8	32	8·296207	3193	11·703793	8·296292	3194	11·703708	10·000085	16 1	9·999915	28	52
30	34	8·299388	3170	11·700612	8·299474	3171	11·700526	10·000086	17 1	9·999914	26	30
9	36	8·302546	3147	11·697454	8·302634	3148	11·697366	10·000087	18 1	9·999913	24	51
30	38	8·305681	3124	11·694319	8·305770	3125	11·694230	10·000089	19 1	9·999911	22	30
10	40	8·308794	3102	11·691206	8·308884	3103	11·691116	10·000090	20 1	9·999910	20	50
30	42	8·311885	3080	11·688115	8·311976	3081	11·688024	10·000091	21 1	9·999909	18	30
11	44	8·314954	3058	11·685046	8·315046	3059	11·684954	10·000093	22 1	9·999907	16	49
30	46	8·318001	3036	11·681999	8·318095	3038	11·681905	10·000094	23 1	9·999906	14	30
12	48	8·321027	3016	11·678973	8·321122	3017	11·678878	10·000095	24 1	9·999905	12	48
30	50	8·324032	2995	11·675968	8·324129	2996	11·675871	10·000097	25 1	9·999903	10	30
13	52	8·327016	2974	11·672984	8·327114	2975	11·672886	10·000098	26 1	9·999902	8	47
30	54	8·329980	2954	11·670020	8·330080	2956	11·669920	10·000099	27 1	9·999901	6	30
14	56	8·332924	2934	11·667076	8·333025	2935	11·666975	10·000101	28 1	9·999899	4	46
30	58	8·335848	2914	11·664152	8·335950	2916	11·664050	10·000102	29 1	9·999898	2	30
15	**5**	8·338753	2895	11·661247	8·338856	2896	11·661144	10·000103	30 1	9·999897	**55**	45
30	2	8·341638	2876	11·658362	8·341743	2877	11·658257	10·000105	1 0	9·999895	58	30
16	4	8·344504	2856	11·655496	8·344610	2858	11·655390	10·000106	2 0	9·999894	56	44
30	0	8·347352	2838	11·652648	8·347459	2840	11·652541	10·000108	3 0	9·999892	54	30
17	8	8·350181	2820	11·649819	8·350289	2821	11·649711	10·000109	4 0	9·999891	52	43
30	10	8·352991	2801	11·647009	8·353101	2803	11·646899	10·000110	5 0	9·999890	50	30
18	12	8·355783	2784	11·644217	8·355895	2784	11·644105	10·000112	6 0	9·999888	48	42
30	14	8·358558	2766	11·641442	8·358671	2768	11·641329	10·000[illegible]3	7 0	9·999887	46	30
19	16	8·361315	2748	11·638685	8·361430	2749	11·638570	10·000115	8 0	9·999885	44	41
30	18	8·364055	2731	11·635945	8·364171	2733	11·635829	10·000116	9 0	9·999884	42	30
20	20	8·366777	2714	11·633223	8·366895	2715	11·633105	10·000118	10 1	9·999882	40	40
30	22	8·369482	2697	11·630518	8·369601	2699	11·630399	10·000119	11 1	9·999881	38	30
21	21	8·372171	2680	11·627829	8·372292	2681	11·627708	10·000121	12 1	9·999879	36	39
30	26	8·374843	2664	11·625157	8·374965	2666	11·625035	10·000122	13 1	9·999878	34	30
22	28	8·377499	2648	11·622501	8·377622	2649	11·622378	10·000124	14 1	9·999876	32	38
30	30	8·380138	2631	11·619862	8·380263	2633	11·619737	10·000125	15 1	9·999875	30	30
23	32	8·382762	2616	11·617238	8·382889	2617	11·617111	10·000127	16 1	9·999873	28	37
30	34	8·385370	2600	11·614630	8·385498	2602	11·614502	10·000128	17 1	9·999872	26	30
24	36	8·387962	2585	11·612038	8·388092	2586	11·611908	10·000130	18 1	9·999870	24	36
30	38	8·390539	2569	11·609461	8·390670	2571	11·609330	10·000131	19 1	9·999869	22	30
25	40	8·393101	2554	11·606899	8·393234	2556	11·606766	10·000133	20 1	9·999867	20	35
30	42	8·395647	2539	11·604352	8·395782	2540	11·604218	10·000134	21 1	9·999866	18	30
26	44	8·398179	2525	11·601821	8·398315	2526	11·601685	10·000136	22 1	9·999864	16	34
30	46	8·400696	2510	11·599304	8·400834	2512	11·599166	10·000137	23 1	9·999863	14	30
27	48	8·403199	2495	11·596801	8·403338	2497	11·596662	10·000139	24 1	9·999861	12	33
30	50	8·405687	2481	11·594313	8·405828	2483	11·594172	10·000141	25 1	9·999859	10	30
28	52	8·408161	2467	11·591839	8·408304	2468	11·591696	10·000142	26 1	9·999858	8	32
30	54	8·410621	2453	11·589379	8·410765	2455	11·589235	10·000144	27 1	9·999856	6	30
29	56	8·413068	2440	11·586932	8·413213	2441	11·586787	10·000146	28 1	9·999854	4	31
30	58	8·415500	2425	11·584500	8·415647	2427	11·584353	10·000147	29 1	9·999853	2	30
30	**6**	8·417919	2412	11·582081	8·418068	2414	11·581932	10·000149	30 2	9·999851	0	30
′ ″	m. s.	Cosine	D.	Secant	Cotang.	D.	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

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′ ″	m. s.	Sine	D.	Cosec.	Tangent	D.	Cotang.	Secant	Parts	Cosine	m.	′ ″
30	0	8·417919	2412	11·582081	8·418068	2414	11·581932	10·000149		9·999851	54	30
30	2	8·420325	2399	11·579675	8·420475	2401	11·579525	10·000151	1″ 0	9·999849	58	30
31	4	8·422717	2386	11·577283	8·422869	2387	11·577131	10·000152	2 0	9·999848	56	29
30	6	8·425096	2373	11·574904	8·425250	2374	11·574750	10·000154	3 0	9·999846	54	30
32	8	8·427462	2359	11·572538	8·427618	2362	11·572382	10·000156	4 0	9·999844	52	28
30	10	8·429815	2347	11·570185	8·429973	2348	11·570027	10·000157	5 0	9·999843	50	30
33	12	8·432156	2335	11·567844	8·432315	2336	11·567685	10·000159	6 0	9·999841	48	27
30	14	8·434484	2322	11·565516	8·434645	2324	11·565355	10·000161	7 0	9·999839	46	30
34	16	8·436800	2309	11·563200	8·436962	2311	11·563038	10·000162	8 0	9·999838		26
30	18	8·439103	2297	11·560897	8·439267	2299	11·560733	10·000164	9 0	9·999836	12	30
35	20	8·441394	2286	11·558606	8·441560	2287	11·558440	10·000166	10 1	9·999834	40	25
30	22	8·443674	2273	11·556326	8·443841	2275	11·556159	10·000168	11 1	9·999832	38	30
36	24	8·445941	2261	11·554059	8·446110	2263	11·553890	10·000169	12 1	9·999831	36	24
30	26	8·448196	2250	11·551804	8·448368	2252	11·551632	10·000171	13 1	9·999829	34	30
37	28	8·450440	2238	11·549560	8·450613	2240	11·549387	10·000173	14 1	9·999827	32	23
30	30	8·452673	2226	11·547327	8·452847	2228	11·547153	10·000175	15 1	9·999825	30	30
38	32	8·454893	2216	11·545107	8·455070	2217	11·544930	10·000176	16 1	9·999824	28	22
30	34	8·457103	2203	11·542897	8·457281	2206	11·542719	10·000178	17 1	9·999822	26	30
39	36	8·459301	2193	11·540699	8·459481	2194	11·540519	10·000180	18 1	9·999820	24	21
30	38	8·461489	2182	11·538511	8·461670	2184	11·538330	10·000182	19 1	9·999818	22	30
40	40	8·463665	2171	11·536335	8·463849	2173	11·536151	10·000184	20 1	9·999816	20	20
30	42	8·465830	2160	11·534170	8·466016	2162	11·533984	10·000186	21 1	9·999814	18	30
41	44	8·467985	2149	11·532015	8·468172	2151	11·531828	10·000187	22 1	9·999813	16	19
30	46	8·470129	2139	11·529871	8·470318	2140	11·529682	10·000189	23 1	9·999811	14	30
42	48	8·472263	2128	11·527737	8·472454	2131	11·527546	10·000191	24 1	9·999809	12	18
30	50	8·474386	2118	11·525614	8·474579	2119	11·525421	10·000193	25 2	9·999807	10	30
43	52	8·476498	2108	11·523502	8·476693	2110	11·523307	10·000195	26 2	9·999805	8	17
30	54	8·478601	2097	11·521399	8·478798	2095	11·521202	10·000197	27 2	9·999803	6	30
44	56	8·480693	2088	11·519307	8·480892	2089	11·519108	10·000199	28 2	9·999801	4	16
30	58	8·482776	2077	11·517224	8·482976	2080	11·517024	10·000201	29 2	9·999799	2	30
45	7	8·484848	2067	11·515152	8·485050	2069	11·514950	10·000203	30 2	9·999797	53	15
30	2	8·486910	2058	11·513090	8·487115	2060	11·512885	10·000205	1 0	9·999795	58	30
46	4	8·488963	2048	11·511037	8·489170	2049	11·510830	10·000206	2 0	9·999794	56	14
30	6	8·491006	2038	11·508994	8·491215	2041	11·508785	10·000208	3 0	9·999792	54	30
47	8	8·493040	2029	11·506960	8·493250	2030	11·506750	10·000210	4 0	9·999790	52	13
30	10	8·495064	2019	11·504936	8·495276	2022	11·504724	10·000212	5 0	9·999788	50	30
48	12	8·497078	2010	11·502922	8·497293	2012	11·502707	10·000214	6 0	9·999786	48	12
30	14	8·499084	2001	11·500916	8·499300	2002	11·500700	10·000216	7 0	9·999784	46	30
49	16	8·501080	1991	11·498920	8·501298	1994	11·498702	10·000218	8 1	9·999782	44	11
30	18	8·503067	1983	11·496933	8·503287	1984	11·496713	10·000220	9 1	9·999780	42	30
50	20	8·505045	1973	11·494955	8·505267	1976	11·494733	10·000222	10 1	9·999778	40	10
30	22	8·507014	1965	11·492986	8·507238	1966	11·492762	10·000224	11 1	9·999776	38	30
51	24	8·508974	1955	11·491026	8·509200	1958	11·490800	10·000226	12 1	9·999774	36	9
30	26	8·510925	1947	11·489075	8·511153	1949	11·488847	10·000228	13 1	9·999772	34	30
52	28	8·512867	1938	11·487133	8·513098	1940	11·486902	10·000231	14 1	9·999769	32	8
30	30	8·514801	1930	11·485199	8·515034	1931	11·484966	10·000233	15 1	9·999767	30	30
53	32	8·516726	1921	11·483274	8·516961	1923	11·483039	10·000235	16 1	9·999765	28	7
30	34	8·518643	1912	11·481357	8·518880	1915	11·481120	10·000237	17 1	9·999763	26	30
54	36	8·520551	1904	11·479449	8·520790	1906	11·479210	10·000239	18 1	9·999761	24	6
30	38	8·522451	1896	11·477549	8·522692	1898	11·477308	10·000241	19 1	9·999759	22	30
55	40	8·524343	1888	11·475657	8·524586	1890	11·475414	10·000243	20 1	9·999757	20	5
30	42	8·526226	1879	11·473774	8·526472	1881	11·473528	10·000245	21 1	9·999755	18	30
56	44	8·528102	1871	11·471898	8·528349	1874	11·471651	10·000247	22 2	9·999753	16	4
30	46	8·529969	1864	11·470031	8·530218	1865	11·469782	10·000249	23 2	9·999751	14	30
57	48	8·531828	1855	11·468172	8·532080	1857	11·467920	10·000252	24 2	9·999748	12	3
30	50	8·533679	1847	11·466321	8·533933	1850	11·466067	10·000254	25 2	9·999746	10	30
58	52	8·535523	1840	11·464477	8·535779	1842	11·464221	10·000256	26 2	9·999744	8	2
30	54	8·537358	1831	11·462642	8·537617	1834	11·462383	10·000258	27 2	9·999742	6	30
59	56	8·539186	1824	11·460814	8·539447	1826	11·460553	10·000260	28 2	9·999740	4	1
30	58	8·541007	1817	11·458993	8·541269	1818	11·458731	10·000262	29 2	9·999738	2	30
60	8	8·542819	1809	11·457181	8·543084	1811	11·456916	10·000265	30 2	9·999735	0	0
′ ″	m. s.	Cosine	D.	Secant	Cotang.	D.	Tangent	Cosec.	Parts	Sine	m.	′ ″

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LOG. SINES, COSINES, &c.

0h 8m — 2°

′ ″	m.	Sine	D.	Cosec.	Tangent	D.	Cotang.	Secant	Parts	Cosine	m.	′ ″
0	0	8·542819	1809	11·457181	8·543084	1811	11·456916	10·000265		9·999735	52	60
30	2	8·544624	1801	11·455376	8·544891	1804	11·455109	10·000267	1″ 0	9·999733	58	30
1	4	8·546422	1794	11·453578	8·546691	1796	11·453309	10·000269	2 0	9·999731	56	59
30	6	8·548212	1786	11·451788	8·548483	1789	11·451517	10·000271	3 0	9·999729	54	30
2	8	8·549995	1779	11·450005	8·550268	1781	11·449732	10·000274	4 0	9·999726	52	58
30	10	8·551770	1772	11·448230	8·552046	1774	11·447954	10·000276	5 0	9·999724	50	30
3	12	8·553539	1765	11·446461	8·553817	1767	11·446183	10·000278	6 0	9·999722	48	57
30	14	8·555300	1758	11·444700	8·555580	1760	11·444420	10·000280	7 1	9·999720	46	30
4	16	8·557054	1750	11·442946	8·557336	1753	11·442664	10·000283	8 1	9·999717	44	56
30	18	8·558801	1743	11·441199	8·559085	1745	11·440915	10·000285	9 1	9·999715	42	30
5	20	8·560540	1737	11·439460	8·560828	1739	11·439172	10·000287	10 1	9·999713	40	55
30	22	8·562273	1729	11·437727	8·562563	1732	11·437437	10·000289	11 1	9·999711	38	30
6	24	8·563999	1723	11·436001	8·564291	1725	11·435709	10·000292	12 1	9·999708	36	54
30	26	8·565719	1716	11·434281	8·566013	1718	11·433987	10·000294	13 1	9·999706	34	30
7	28	8·567431	1709	11·432569	8·567727	1711	11·432273	10·000296	14 1	9·999704	32	53
30	30	8·569137	1702	11·430863	8·569435	1705	11·430565	10·000299	15 1	9·999701	30	30
8	32	8·570836	1696	11·429164	8·571137	1698	11·428863	10·000301	16 1	9·999699	28	52
30	34	8·572528	1689	11·427472	8·572832	1692	11·427168	10·000304	17 1	9·999696	26	30
9	36	8·574214	1682	11·425786	8·574520	1684	11·425480	10·000306	18 1	9·999694	24	51
30	38	8·575893	1676	11·424107	8·576201	1679	11·423799	10·000308	19 1	9·999692	22	30
10	40	8·577566	1670	11·422434	8·577877	1672	11·422123	10·000311	20 2	9·999689	20	50
30	42	8·579232	1663	11·420768	8·579545	1665	11·420455	10·000313	21 2	9·999687	18	30
11	44	8·580892	1657	11·419108	8·581208	1660	11·418792	10·000315	22 2	9·999685	16	49
30	46	8·582546	1650	11·417454	8·582864	1652	11·417136	10·000318	23 2	9·999682	14	30
12	48	8·584193	1645	11·415807	8·584514	1647	11·415486	10·000320	24 2	9·999680	12	48
30	50	8·585834	1638	11·414166	8·586157	1641	11·413843	10·000323	25 2	9·999677	10	30
13	52	8·587469	1632	11·412531	8·587795	1634	11·412205	10·000325	26 2	9·999675	8	47
30	54	8·589098	1625	11·410902	8·589426	1628	11·410574	10·000328	27 2	9·999672	6	30
14	56	8·590721	1620	11·409279	8·591051	1622	11·408949	10·000330	28 2	9·999670	4	46
30	58	8·592338	1614	11·407662	8·592670	1616	11·407330	10·000332	29 2	9·999668	2	30
15	9	8·593948	1607	11·406052	8·594283	1611	11·405717	10·000335	30 2	9·999665	51	45
30	2	8·595553	1602	11·404447	8·595890	1604	11·404110	10·000337	1 0	9·999663	58	30
16	4	8·597152	1596	11·402848	8·597492	1598	11·402508	10·000340	2 0	9·999660	56	44
30	6	8·598745	1590	11·401255	8·599087	1593	11·400913	10·000342	3 0	9·999658	54	30
17	8	8·600332	1584	11·399668	8·600677	1586	11·399323	10·000345	4 0	9·999655	52	43
30	10	8·601913	1579	11·398087	8·602260	1581	11·397740	10·000347	5 0	9·999653	50	30
18	12	8·603489	1572	11·396511	8·603839	1576	11·396161	10·000350	6 1	9·999650	48	42
30	14	8·605058	1567	11·394942	8·605411	1569	11·394589	10·000353	7 1	9·999647	46	30
19	16	8·606623	1562	11·393377	8·606978	1564	11·393022	10·000355	8 1	9·999645	44	41
30	18	8·608181	1555	11·391819	8·608539	1558	11·391461	10·000358	9 1	9·999642	42	30
20	20	8·609734	1551	11·390266	8·610094	1553	11·389906	10·000360	10 1	9·999640	40	40
30	22	8·611282	1544	11·388718	8·611644	1547	11·388356	10·000363	11 1	9·999637	38	30
21	24	8·612823	1539	11·387177	8·613189	1542	11·386811	10·000365	12 1	9·999635	36	39
30	26	8·614360	1534	11·385640	8·614728	1536	11·385272	10·000368	13 1	9·999632	34	30
22	28	8·615891	1529	11·384109	8·616262	1531	11·383738	10·000371	14 1	9·999629	32	38
30	30	8·617417	1522	11·382583	8·617790	1526	11·382210	10·000373	15 1	9·999627	30	30
23	32	8·618937	1518	11·381063	8·619313	1520	11·380687	10·000376	16 1	9·999624	28	37
30	34	8·620452	1512	11·379548	8·620830	1515	11·379170	10·000378	17 2	9·999622	26	30
24	36	8·621962	1508	11·378038	8·622343	1510	11·377657	10·000381	18 2	9·999619	24	36
30	38	8·623466	1501	11·376534	8·623850	1505	11·376150	10·000384	19 2	9·999616	22	30
25	40	8·624965	1497	11·375035	8·625352	1499	11·374648	10·000386	20 2	9·999614	20	35
30	42	8·626459	1492	11·373541	8·626849	1494	11·373151	10·000389	21 2	9·999611	18	30
26	44	8·627948	1486	11·372052	8·628340	1489	11·371660	10·000392	22 2	9·999608	16	34
30	46	8·629432	1481	11·370568	8·629827	1484	11·370173	10·000394	23 2	9·999606	14	30
27	48	8·630911	1477	11·369089	8·631308	1479	11·368692	10·000397	24 2	9·999603	12	33
30	50	8·632385	1471	11·367615	8·632785	1474	11·367215	10·000400	25 2	9·999600	10	30
28	52	8·633854	1466	11·366146	8·634256	1469	11·365744	10·000403	26 2	9·999597	8	32
30	54	8·635317	1462	11·364683	8·635723	1464	11·364277	10·000405	27 2	9·999595	6	30
29	56	8·636776	1456	11·363224	8·637184	1459	11·362816	10·000408	28 3	9·999592	4	31
30	58	8·638230	1452	11·361770	8·638641	1455	11·361359	10·000411	29 3	9·999589	2	30
30	10	8·639680	1446	11·360320	8·640093	1449	11·359907	10·000414	30 3	9·999586	0	30
′ ″	m.	Cosine	D.	Secant	Cotang.	D.	Tangent	Cosec.	Parts	Sine	m.	′ ″

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LOG. SINES, COSINES, &c.

0ʰ 10ᵐ — 2°

′ ″	m. s.	Sine	D.	Cosec.	Tangent	D.	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
30	0	8·639680	1446	11·360320	8·640093	1449	11·359907	10·000414		9·999586	50	30
30	2	8·641124	1442	11·358876	8·641540	1445	11·358460	10·000416	1″ 0	9·999584	58	30
31	4	8·642563	1437	11·357437	8·642982	1440	11·357018	10·000419	2 0	9·999581	56	29
30	6	8·643998	1433	11·356002	8·644420	1435	11·355580	10·000422	3 0	9·999578	54	30
32	8	8·645428	1427	11·354572	8·645853	1431	11·354147	10·000425	4 0	9·999575	52	28
30	10	8·646854	1423	11·353146	8·647281	1425	11·352719	10·000427	5 0	9·999573	50	30
33	12	8·648274	1419	11·351726	8·648704	1421	11·351296	10·000430	6 1	9·999570	48	27
30	14	8·649690	1413	11·350310	8·650123	1417	11·349877	10·000433	7 1	9·999567	46	30
34	16	8·651102	1410	11·348898	8·651537	1412	11·348463	10·000436	8 1	9·999564	44	26
30	18	8·652508	1404	11·347492	8·652947	1407	11·347053	10·000439	9 1	9·999561	42	30
35	20	8·653911	1400	11·346089	8·654352	1403	11·345648	10·000442	10 1	9·999558	40	25
30	22	8·655308	1396	11·344692	8·655753	1399	11·344247	10·000444	11 1	9·999556	38	30
36	24	8·656702	1391	11·343298	8·657149	1393	11·342851	10·000447	12 1	9·999553	36	24
30	26	8·658090	1386	11·341910	8·658541	1390	11·341459	10·000450	13 1	9·999550	34	30
37	28	8·659475	1382	11·340525	8·659928	1385	11·340072	10·000453	14 1	9·999547	32	23
30	30	8·660855	1378	11·339145	8·661311	1381	11·338689	10·000456	15 1	9·999544	30	30
38	32	8·662230	1373	11·337770	8·662689	1376	11·337311	10·000459	16 2	9·999541	28	22
30	34	8·663602	1370	11·336398	8·664063	1372	11·335937	10·000462	17 2	9·999538	26	30
39	36	8·664968	1364	11·335032	8·665433	1367	11·334567	10·000465	18 2	9·999535	24	21
30	38	8·666331	1361	11·333669	8·666799	1364	11·333201	10·000468	19 2	9·999532	22	30
40	40	8·667689	1356	11·332311	8·668160	1359	11·331840	10·000471	20 2	9·999529	20	20
30	42	8·669043	1352	11·330957	8·669517	1355	11·330483	10·000473	21 2	9·999527	18	30
41	44	8·670393	1348	11·329607	8·670870	1351	11·329130	10·000476	22 2	9·999524	16	19
30	46	8·671739	1343	11·328261	8·672218	1346	11·327782	10·000479	23 2	9·999521	14	30
42	48	8·673080	1340	11·326920	8·673563	1343	11·326437	10·000482	24 2	9·999518	12	18
30	50	8·674418	1335	11·325582	8·674903	1338	11·325097	10·000485	25 2	9·999515	10	30
43	52	8·675751	1331	11·324249	8·676239	1334	11·323761	10·000488	26 3	9·999512	8	17
30	54	8·677080	1327	11·322920	8·677572	1330	11·322428	10·000491	27 3	9·999509	6	30
44	56	8·678405	1323	11·321595	8·678900	1326	11·321100	10·000494	28 3	9·999506	4	16
30	58	8·679726	1319	11·320274	8·680224	1322	11·319776	10·000497	29 3	9·999503	2	30
45	11	8·681043	1315	11·318957	8·681544	1318	11·318456	10·000500	30 3	9·999500	49	15
30	2	8·682356	1311	11·317644	8·682860	1314	11·317140	10·000503	1 0	9·999497	58	30
46	4	8·683665	1308	11·316335	8·684172	1311	11·315828	10·000507	2 0	9·999493	56	14
30	6	8·684971	1303	11·315029	8·685480	1306	11·314520	10·000510	3 0	9·999490	54	30
47	8	8·686272	1299	11·313728	8·686784	1302	11·313216	10·000513	4 0	9·999487	52	13
30	10	8·687569	1295	11·312431	8·688085	1299	11·311915	10·000516	5 1	9·999484	50	3
48	12	8·688863	1292	11·311137	8·689381	1294	11·310619	10·000519	6 1	9·999481	48	12
30	14	8·690152	1288	11·309848	8·690674	1291	11·309326	10·000522	7 1	9·999478	46	30
49	16	8·691438	1283	11·308562	8·691963	1287	11·308037	10·000525	8 1	9·999475	44	11
30	18	8·692720	1280	11·307280	8·693248	1283	11·306752	10·000528	9 1	9·999472	42	30
50	20	8·693998	1277	11·306002	8·694529	1280	11·305471	10·000531	10 1	9·999469	40	10
30	22	8·695272	1272	11·304728	8·695807	1275	11·304193	10·000534	11 1	9·999466	38	30
51	24	8·696543	1269	11·303457	8·697081	1272	11·302919	10·000537	12 1	9·999463	36	9
30	26	8·697810	1265	11·302190	8·698351	1268	11·301649	10·000541	13 1	9·999459	34	30
52	28	8·699073	1262	11·300927	8·699617	1265	11·300383	10·000544	14 1	9·999456	32	8
30	30	8·700333	1257	11·299667	8·700880	1261	11·299120	10·000547	15 2	9·999453	30	30
53	32	8·701589	1255	11·298411	8·702139	1257	11·297861	10·000550	16 2	9·999450	28	7
30	34	8·702841	1250	11·297159	8·703395	1254	11·296605	10·000553	17 2	9·999447	26	30
54	36	8·704090	1247	11·295910	8·704646	1250	11·295354	10·000557	18 2	9·999443	24	6
30	38	8·705335	1243	11·294665	8·705895	1247	11·294105	10·000560	19 2	9·999440	22	30
55	40	8·706577	1240	11·293423	8·707140	1243	11·292860	10·000563	20 2	9·999437	20	5
30	42	8·707815	1236	11·292185	8·708381	1239	11·291619	10·000566	21 2	9·999434	18	30
56	44	8·709049	1233	11·290951	8·709618	1236	11·290382	10·000569	22 2	9·999431	16	4
30	46	8·710280	1229	11·289720	8·710853	1233	11·289147	10·000573	23 2	9·999427	14	30
57	48	8·711507	1226	11·288493	8·712083	1228	11·287917	10·000576	24 2	9·999424	12	3
30	50	8·712731	1222	11·287268	8·713311	1226	11·286689	10·000579	25 3	9·999421	10	30
58	52	8·713952	1219	11·286048	8·714534	1222	11·285466	10·000582	26 3	9·999418	8	2
30	54	8·715169	1216	11·284831	8·715755	1219	11·284245	10·000586	27 3	9·999414	6	30
59	56	8·716383	1212	11·283617	8·716972	1215	11·283028	10·000589	28 3	9·999411	4	1
30	58	8·717593	1208	11·282406	8·718186	1212	11·281814	10·000592	29 3	9·999408	2	30
60	12	8·718800	1205	11·281200	8·719396	1209	11·280604	10·000596	30 3	9·999404	0	0
′ ″	m.	Cosine	D.	Secant	Cotang.	D.	Tangent	Cosec.	Parts	Sine	m.	′ ″

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LOG. SINES, COSINES, &c.

0ʰ 12ᵐ | 3°

′ ″	m. s.	Sine	D.	Cosec.	Tangent	D.	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	8·718800	1205	11·281200	8·719396	1209	11·280604	10·000596		9·999404	**48**	**60**
30	2	8·720004	1202	11·279996	8·720603	1205	11·279397	10·000599	1″ 0	9·999401	58	30
1	4	8·721204	1199	11·278796	8·721806	1202	11·278194	10·000602	2 0	9·999398	56	**59**
30	6	8·722401	1195	11·277599	8·723007	1198	11·276993	10·000606	3 0	9·999394	54	30
2	8	8·723595	1192	11·276405	8·724204	1196	11·275796	10·000609	4 0	9·999391	52	**58**
30	10	8·724785	1189	11·275215	8·725397	1192	11·274603	10·000612	5 1	9·999388	50	30
3	12	8·725972	1185	11·274028	8·726588	1189	11·273412	10·000616	6 1	9·999384	48	**57**
30	14	8·727156	1183	11·272844	8·727775	1185	11·272225	10·000619	7 1	9·999381	46	30
4	16	8·728337	1179	11·271663	8·728959	1183	11·271041	10·000622	8 1	9·999378	44	**56**
30	18	8·729514	1176	11·270486	8·730140	1179	11·269860	10·000626	9 1	9·999374	42	30
5	20	8·730688	1172	11·269312	8·731317	1176	11·268683	10·000629	10 1	9·999371	40	**55**
30	22	8·731859	1170	11·268141	8·732492	1173	11·267508	10·000633	11 1	9·999367	38	30
6	24	8·733027	1166	11·266973	8·733663	1170	11·266337	10·000636	12 1	9·999364	36	**54**
30	26	8·734192	1163	11·265808	8·734831	1166	11·265169	10·000639	13 1	9·999361	34	30
7	28	8·735354	1160	11·264646	8·735996	1164	11·264004	10·000643	14 2	9·999357	32	**53**
30	30	8·736512	1157	11·263488	8·737158	1160	11·262842	10·000646	15 2	9·999354	30	30
8	32	8·737667	1154	11·262333	8·738317	1158	11·261683	10·000650	16 2	9·559350	28	**52**
30	34	8·738820	1151	11·261180	8·739473	1154	11·260527	10·000653	17 2	9·999347	26	30
9	36	8·739969	1148	11·260031	8·740626	1151	11·259374	10·000657	18 2	9·999343	24	**51**
30	38	8·741115	1144	11·258885	8·741776	1148	11·258224	10·000660	19 2	9·999340	22	30
10	40	8·742259	1142	11·257741	8·742922	1146	11·257078	10·000664	20 2	9·999336	20	**50**
30	42	8·743399	1139	11·256601	8·744066	1142	11·255934	10·000667	21 2	9·999333	18	30
11	44	8·744536	1136	11·255464	8·745207	1139	11·254793	10·000671	22 3	9·999329	16	**49**
30	46	8·745670	1132	11·254330	8·746344	1136	11·253656	10·000674	23 3	9·999326	14	30
12	48	8·746802	1130	11·253198	8·747479	1134	11·252521	10·000678	24 3	9·999322	12	**48**
30	50	8·747930	1127	11·252070	8·748611	1130	11·251389	10·000681	25 3	9·999319	10	30
13	52	8·749055	1124	11·250945	8·749740	1127	11·250260	10·000685	26 3	9·999315	8	**47**
30	54	8·750178	1121	11·249822	8·750866	1125	11·249134	10·000688	27 3	9·999312	6	30
14	56	8·751297	1118	11·248703	8·751989	1122	11·248011	10·000692	28 3	9·999308	4	**46**
30	58	8·752414	1115	11·247586	8·753109	1119	11·246891	10·000695	29 3	9·999305	2	30
15	**13**	8·753528	1113	11·246472	8·754227	1116	11·245773	10·000699	30 3	9·999301	**47**	**45**
30	2	8·754639	1109	11·245361	8·755341	1113	11·244659	10·000703	1 0	9·999297	58	30
16	4	8·755747	1107	11·244253	8·756453	1110	11·243547	10·000706	2 0	9·999294	56	**44**
30	6	8·756852	1104	11·243148	8·757562	1107	11·242438	10·000710	3 0	9·999290	54	30
17	8	8·757955	1101	11·242045	8·758668	1105	11·241332	10·000713	4 0	9·999287	52	**43**
30	10	8·759054	1098	11·240946	8·759771	1102	11·240229	10·000717	5 1	9·999283	50	30
18	12	8·760151	1096	11·239849	8·760872	1099	11·239128	10·000721	6 1	9·999279	48	**42**
30	14	8·761245	1092	11·238755	8·761970	1097	11·238030	10·000724	7 1	9·999276	46	30
19	16	8·762337	1090	11·237663	8·763065	1093	11·236935	10·000728	8 1	9·999272	44	**41**
30	18	8·763425	1088	11·236575	8·764157	1091	11·235843	10·000732	9 1	9·999268	42	30
20	20	8·764511	1084	11·235489	8·765246	1088	11·234754	10·000735	10 1	9·999265	40	**40**
30	22	8·765594	1082	11·234406	8·766333	1086	11·233667	10·000739	11 1	9·999261	38	**30**
21	24	8·766675	1079	11·233325	8·767417	1083	11·232583	10·000743	12 1	9·999257	36	**39**
30	26	8·767752	1076	11·232248	8·768499	1080	11·231501	10·000746	13 2	9·999254	34	30
22	28	8·768828	1074	11·231172	8·769578	1077	11·230422	10·000750	14 2	9·999250	32	**38**
30	30	8·769900	1071	11·230100	8·770654	1075	11·229346	10·000754	15 2	9·999246	30	30
23	32	8·770970	1069	11·229030	8·771727	1072	11·228273	10·000758	16 2	9·999242	28	**37**
30	34	8·772037	1065	11·227963	8·772798	1070	11·227202	10·000761	17 2	9·999239	26	30
24	36	8·773101	1064	11·226899	8·773866	1067	11·226134	10·000765	18 2	9·999235	24	**36**
30	38	8·774163	1060	11·225837	8·774932	1064	11·225068	10·000769	19 2	9·999231	22	30
25	40	8·775223	1058	11·224777	8·775995	1062	11·224005	10·000773	20 2	9·999227	20	**35**
30	42	8·776279	1056	11·223721	8·777056	1059	11·222944	10·000776	21 3	9·999224	18	30
26	44	8·777333	1053	11·222667	8·778114	1057	11·221886	10·000780	22 3	9·999220	16	**34**
30	46	8·778385	1050	11·221615	8·779169	1054	11·220831	10·000784	23 3	9·999216	14	30
27	48	8·779434	1048	11·220566	8·780222	1051	11·219778	10·000788	24 3	9·999212	12	**33**
30	50	8·780480	1045	11·219520	8·781272	1049	11·218728	10·000792	25 3	9·999208	10	30
28	52	8·781524	1043	11·218476	8·782320	1047	11·217680	10·000795	26 3	9·999205	8	**32**
30	54	8·782566	1040	11·217434	8·783365	1044	11·216635	10·000799	27 3	9·999201	6	30
29	56	8·783605	1037	11·216395	8·784408	1041	11·215592	10·000803	28 3	9·999197	4	**31**
30	58	8·784641	1036	11·215359	8·785448	1040	11·214552	10·000807	29 4	9·999193	2	30
30	**14**	8·785675	1032	11·214325	8·786486	1036	11·213514	10·000811	30 4	9·999189	0	**30**
′ ″	m. s.	Cosine	D.	Secant	Cotang.	D.	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

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LOG. SINES, COSINES, &c.

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′ ″	m. s.	Sine	D.	Cosec.	Tangent	D.	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
30	0	8·785675	1032	11·214325	8·786486	1036	11·213514	10·000811		9·999189	46	30
30	2	8·786707	1031	11·213293	8·787521	1034	11·212479	10·000815	1″ 0	9·999185	58	30
31	4	8·787736	1028	11·212264	8·788554	1032	11·211446	10·000819	2 0	9·999181	56	29
30	6	8·788762	1025	11·211238	8·789585	1029	11·210415	10·000822	3 0	9·999178	54	30
32	8	8·789787	1023	11·210213	8·790613	1027	11·209387	10·000826	4 1	9·999174	52	28
30	10	8·790808	1020	11·209192	8·791639	1025	11·208361	10·000830	5 1	9·999170	50	30
33	12	8·791828	1019	11·208172	8·792662	1022	11·207338	10·000834	6 1	9·999166	48	27
30	14	8·792845	1015	11·207155	8·793683	1019	11·206317	10·000838	7 1	9·999162	46	30
34	16	8·793859	1014	11·206141	8·794701	1018	11·205299	10·000842	8 1	9·999158	44	26
30	18	8·794872	1011	11·205128	8·795718	1015	11·204282	10·000846	9 1	9·999154	42	30
35	20	8·795881	1009	11·204119	8·796731	1012	11·203269	10·000850	10 1	9·999150	40	25
30	22	8·796889	1006	11·203111	8·797743	1011	11·202257	10·000854	11 1	9·999146	38	30
36	24	8·797894	1004	11·202106	8·798752	1008	11·201248	10·000858	12 2	9·999142	36	24
30	26	8·798897	1001	11·201103	8·799759	1005	11·200241	10·000862	13 2	9·999138	34	30
37	28	8·799897	1000	11·200103	8·800763	1004	11·199237	10·000866	14 2	9·999134	32	23
30	30	8·800896	997	11·199104	8·801765	1001	11·198235	10·000870	15 2	9·999130	30	30
38	32	8·801892	995	11·198108	8·802765	998	11·197235	10·000874	16 2	9·999126	28	22
30	34	8·802885	992	11·197115	8·803763	997	11·196237	10·000878	17 2	9·999122	26	30
39	36	8·803876	990	11·196124	8·804758	994	11·195242	10·000882	18 2	9·999118	24	21
30	38	8·804866	988	11·195134	8·805751	992	11·194249	10·000886	19 3	9·999114	22	30
40	40	8·805852	986	11·194148	8·806742	990	11·193258	10·000890	20 3	9·999110	20	20
30	42	8·806837	983	11·193163	8·807731	987	11·192269	10·000894	21 3	9·999106	18	30
41	44	8·807819	982	11·192181	8·808717	986	11·191283	10·000898	22 3	9·999102	16	19
30	46	8·808799	979	11·191201	8·809701	983	11·190299	10·000902	23 3	9·999098	14	30
42	48	8·809777	976	11·190223	8·810683	981	11·189317	10·000906	24 3	9·999094	12	18
30	50	8·810753	975	11·189247	8·811663	978	11·188337	10·000910	25 3	9·999090	10	30
43	52	8·811726	972	11·188274	8·812641	977	11·187359	10·000914	26 3	9·999086	8	17
30	54	8·812698	971	11·187302	8·813616	974	11·186384	10·000918	27 4	9·999082	6	30
44	56	8·813667	968	11·186333	8·814589	972	11·185411	10·000923	28 4	9·999077	4	16
30	58	8·814634	965	11·185366	8·815560	970	11·184440	10·000927	29 4	9·999073	2	30
45	**15**	8·815599	964	11·184401	8·816529	968	11·183471	10·000931	30 4	9·999069	**45**	15
30	2	8·816561	962	11·183439	8·817496	966	11·182504	10·000935	1 0	9·999065	58	30
46	4	8·817522	959	11·182478	8·818461	963	11·181539	10·000939	2 0	9·999061	56	14
30	6	8·818480	958	11·181520	8·819423	962	11·180577	10·000943	3 0	9·999057	54	30
47	8	8·819436	955	11·180564	8·820384	959	11·179616	10·000947	4 1	9·999053	52	13
30	10	8·820390	953	11·179610	8·821342	958	11·178658	10·000952	5 1	9·999048	50	30
48	12	8·821343	951	11·178657	8·822298	955	11·177702	10·000956	6 1	9·999044	48	12
30	14	8·822292	949	11·177708	8·823253	953	11·176747	10·000960	7 1	9·999040	46	30
49	16	8·823240	947	11·176760	8·824205	951	11·175795	10·000964	8 1	9·999036	44	11
30	18	8·824186	944	11·175814	8·825155	949	11·174845	10·000968	9 1	9·999032	42	30
50	20	8·825130	943	11·174870	8·826103	947	11·173897	10·000973	10 1	9·999027	40	10
30	22	8·826072	941	11·173928	8·827049	945	11·172951	10·000977	11 2	9·999023	38	30
51	24	8·827011	938	11·172989	8·827992	943	11·172008	10·000981	12 2	9·999019	36	9
30	26	8·827949	937	11·172051	8·828934	941	11·171066	10·000985	13 2	9·999015	34	30
52	28	8·828884	934	11·171116	8·829874	938	11·170126	10·000990	14 2	9·999010	32	8
30	30	8·829818	933	11·170182	8·830812	937	11·169188	10·000994	15 2	9·999006	30	30
53	32	8·830749	931	11·169251	8·831748	935	11·168252	10·000998	16 2	9·999002	28	7
30	34	8·831679	928	11·168321	8·832682	933	11·167318	10·001003	17 2	9·998997	26	30
54	36	8·832607	927	11·167393	8·833613	931	11·166387	10·001007	18 3	9·998993	24	6
30	38	8·833[illegible]32	924	11·166468	8·834543	929	11·165457	10·001011	19 3	9·998989	22	30
55	40	8·834456	923	11·165544	8·835471	926	11·164529	10·001016	20 3	9·998984	20	5
30	42	8·835377	920	11·164623	8·836397	925	11·163603	10·001020	21 3	9·998980	18	30
56	44	8·836297	919	11·163703	8·837321	923	11·162679	10·001024	22 3	9·998976	16	4
30	46	8·837215	917	11·162785	8·838243	922	11·161757	10·001029	23 3	9·998971	14	30
57	48	8·838130	915	11·161870	8·839163	919	11·160837	10·001033	24 3	9·998967	12	3
30	50	8·839044	912	11·160956	8·840081	917	11·159919	10·001037	25 4	9·998963	10	30
58	52	8·839956	911	11·160044	8·840998	915	11·159002	10·001042	26 4	9·998958	8	2
30	54	8·840866	909	11·159134	8·841912	914	11·158088	10·001046	27 4	9·998954	6	30
59	56	8·841774	907	11·158226	8·842825	911	11·157175	10·001050	28 4	9·998950	4	1
30	58	8·842680	906	11·157320	8·843735	910	11·156265	10·001055	29 4	9·998945	2	30
60	**16**	8·843585	903	11·156415	8·844644	907	11·155356	10·001059	30 4	9·998941	0	0
′ ″	m. s.	Cosine	D.	Secant	Cotang.	D.	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

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LOG. SINES, COSINES, &c.

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′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	8·843585		11·156415	8·844644		11·155356	10·001059		9·998941	44	60
30	2	8·844487	1″ 30	11·155513	8·845551	1″ 30	11·154449	10·001064	1″ 0	9·998936	58	30
1	4	8·845387	2 60	11·154613	8·846455	2 60	11·153545	10·001068	2 0	9·998932	56	59
30	6	8·846286	3 89	11·153714	8·847358	3 90	11·152642	10·001073	3 0	9·998927	54	30
2	8	8·847183	4 119	11·152817	8·848260	4 120	11·151740	10·001077	4 1	9·998923	52	58
30	10	8·848078	5 149	11·151922	8·849159	5 150	11·150841	10·001081	5 1	9·998919	50	30
3	12	8·848971	6 179	11·151029	8·850057	6 180	11·149943	10·001086	6 1	9·998914	48	57
30	14	8·849862	7 208	11·150138	8·850952	7 210	11·149048	10·001090	7 1	9·998910	46	30
4	16	8·850751	8 238	11·149249	8·851846	8 239	11·148154	10·001095	8 1	9·998905	44	56
30	18	8·851639	9 268	11·148361	8·852738	9 269	11·147262	10·001099	9 1	9·998901	42	30
5	20	8·852525	10 298	11·147475	8·853628	10 299	11·146372	10·001104	10 2	9·998896	40	55
30	22	8·853408	1 29	11·146592	8·854517	1 29	11·145483	10·001108	11 2	9·998892	38	30
6	24	8·854291	2 58	11·145709	8·855403	2 59	11·144597	10·001113	12 2	9·998887	36	54
30	26	8·855171	3 88	11·144829	8·856288	3 88	11·143712	10·001117	13 2	9·998883	34	30
7	28	8·856049	4 117	11·143951	8·857171	4 117	11·142829	10·001122	14 2	9·998878	32	53
30	30	8·856926	5 146	11·143074	8·858053	5 146	11·141947	10·001127	15 2	9·998873	30	30
8	32	8·857801	6 175	11·142199	8·858932	6 176	11·141068	10·001131	16 2	9·998869	28	52
30	34	8·858674	7 204	11·141326	8·859810	7 205	11·140190	10·001136	17 3	9·998864	26	30
9	36	8·859546	8 233	11·140454	8·860686	8 234	11·139314	10·001140	18 3	9·998860	24	51
30	38	8·860415	9 263	11·139585	8·861560	9 264	11·138440	10·001145	19 3	9·998855	22	30
10	40	8·861283	10 292	11·138717	8·862433	10 293	11·137567	10·001149	20 3	9·998851	20	50
30	42	8·862149	1 29	11·137851	8·863303	1 29	11·136697	10·001154	21 3	9·998846	18	30
11	44	8·863014	2 57	11·136986	8·864173	2 58	11·135827	10·001159	22 3	9·998841	16	49
30	46	8·863877	3 86	11·136123	8·865040	3 86	11·134960	10·001163	23 3	9·998837	14	30
12	48	8·864738	4 114	11·135262	8·865906	4 115	11·134094	10·001168	24 4	9·998832	12	48
30	50	8·865597	5 143	11·134403	8·866769	5 144	11·133231	10·001173	25 4	9·998827	10	30
13	52	8·866455	6 172	11·133545	8·867632	6 173	11·132368	10·001177	26 4	9·998823	8	47
30	54	8·867310	7 200	11·132690	8·868492	7 201	11·131508	10·001182	27 4	9·998818	6	30
14	56	8·868165	8 229	11·131835	8·869351	8 230	11·130649	10·001187	28 4	9·998813	4	46
30	58	8·869017	9 257	11·130983	8·870208	9 259	11·129792	10·001191	29 4	9·998809	2	30
15	**17**	8·869868	10 286	11·130132	8·871064	10 288	11·128936	10·001196	30 5	9·998804	**43**	45
30	2	8·870717	1 28	11·129283	8·871918	1 28	11·128082	10·001201	1 0	9·998799	58	30
16	4	8·871565	2 56	11·128435	8·872770	2 56	11·127230	10·001205	2 0	9·998795	56	44
30	6	8·872410	3 84	11·127590	8·873620	3 85	11·126380	10·001210	3 0	9·998790	54	30
17	8	8·873255	4 112	11·126745	8·874469	4 113	11·125531	10·001215	4 1	9·998785	52	43
30	10	8·874097	5 140	11·125903	8·875317	5 141	11·124683	10·001219	5 1	9·998781	50	30
18	12	8·874938	6 168	11·125062	8·876162	6 169	11·123838	10·001224	6 1	9·998776	48	42
30	14	8·875777	7 196	11·124223	8·877006	7 197	11·122994	10·001229	7 1	9·998771	46	30
19	16	8·876615	8 224	11·123385	8·877849	8 225	11·122151	10·001234	8 1	9·998766	44	41
30	18	8·877451	9 252	11·122549	8·878689	9 254	11·121311	10·001238	9 1	9·998762	42	30
20	20	8·878285	10 280	11·121715	8·879529	10 282	11·120471	10·001243	10 2	9·998757	40	40
30	22	8·879118	1 27	11·120882	8·880366	1 28	11·119634	10·001248	11 2	9·998752	38	30
21	24	8·879949	2 55	11·120051	8·881202	2 55	11·118798	10·001253	12 2	9·998747	36	39
30	26	8·880779	3 82	11·119221	8·882037	3 83	11·117963	10·001258	13 2	9·998742	34	30
22	28	8·881607	4 110	11·118393	8·882869	4 111	11·117131	10·001262	14 2	9·998738	32	38
30	30	8·882433	5 137	11·117567	8·883701	5 138	11·116299	10·001267	15 2	9·998733	30	30
23	32	8·883258	6 165	11·116742	8·884530	6 166	11·115470	10·001272	16 3	9·998728	28	37
30	34	8·884081	7 192	11·115919	8·885358	7 193	11·114642	10·001277	17 3	9·998723	26	30
24	36	8·884903	8 220	11·115097	8·886185	8 221	11·113815	10·001282	18 3	9·998718	24	36
30	38	8·885723	9 247	11·114277	8·887010	9 249	11·112990	10·001287	19 3	9·998713	22	30
25	40	8·886542	10 275	11·113458	8·887833	10 276	11·112167	10·001292	20 3	9·998708	20	35
30	42	8·887359	1 27	11·112641	8·888655	1 27	11·111345	10·001296	21 3	9·998704	18	30
26	44	8·888174	2 54	11·111826	8·889476	2 54	11·110524	10·001301	22 4	9·998699	16	34
30	46	8·888988	3 81	11·111012	8·890295	3 81	11·109705	10·001306	23 4	9·998694	14	30
27	48	8·889801	4 108	11·110199	8·891112	4 109	11·108888	10·001311	24 4	9·998689	12	33
30	50	8·890612	5 135	11·109388	8·891928	5 136	11·108072	10·001316	25 4	9·998684	10	30
28	52	8·891421	6 162	11·108579	8·892742	6 163	11·107258	10·001321	26 4	9·998679	8	32
30	54	8·892229	7 189	11·107771	8·893555	7 190	11·106445	10·001326	27 4	9·998674	6	30
29	56	8·893035	8 216	11·106965	8·894366	8 217	11·105634	10·001331	28 5	9·998669	4	31
30	58	8·893840	9 243	11·106160	8·895176	9 244	11·104824	10·001336	29 5	9·998664	2	30
30	**18**	8·894643	10 270	11·105357	8·895984	10 271	11·104016	10·001341	30 5	9·998659	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

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LOG. SINES, COSINES, &c.

0h 18m 4°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
30	0	8·894643		11·105357	8·895984		11·104016	10·001341		9·998659	42	30
30	2	8·895445	1″ 26	11·104555	8·896791	1″ 27	11·103209	10·001346	1″ 0	9·998654	58	30
31	4	8·896246	2 53	11·103754	8·897596	2 53	11·102404	10·001351	2 0	9·998649	56	29
30	6	8·897044	3 79	11·102956	8·898400	3 80	11·101600	10·001356	3 1	9·998644	54	30
32	8	8·897842	4 106	11·102158	8·899203	4 107	11·100797	10·001361	4 1	9·998639	52	28
30	10	8·898638	5 132	11·101362	8·900004	5 133	11·099996	10·001366	5 1	9·998634	50	30
33	12	8·899432	6 159	11·100568	8·900803	6 160	11·099197	10·001371	6 1	9·998629	48	27
30	14	8·900225	7 185	11·099775	8·901601	7 186	11·098399	10·001376	7 1	9·998624	46	30
34	16	8·901017	8 212	11·098983	8·902398	8 213	11·097602	10·001381	8 1	9·998619	44	26
30	18	8·901807	9 238	11·098193	8·903193	9 240	11·096807	10·001386	9 2	9·998614	42	30
35	20	8·902596	10 265	11·097404	8·903987	10 266	11·096013	10·001391	10 2	9·998609	40	25
30	22	8·903383	1 26	11·096617	8·904779	1 26	11·095221	10·001396	11 2	9·998604	38	30
36	24	8·904169	2 52	11·095831	8·905570	2 52	11·094430	10·001401	12 2	9·998599	36	24
30	26	8·904953	3 78	11·095047	8·906359	3 79	11·093641	10·001406	13 2	9·998594	34	30
37	28	8·905736	4 104	11·094264	8·907147	4 105	11·092853	10·001411	14 2	9·998589	32	23
30	30	8·906517	5 130	11·093483	8·907934	5 131	11·092066	10·001416	15 3	9·998584	30	30
38	32	8·907297	6 156	11·092703	8·908719	6 157	11·091281	10·001422	16 3	9·998578	28	22
30	34	8·908076	7 182	11·091924	8·909503	7 183	11·090497	10·001427	17 3	9·998573	26	30
39	36	8·908853	8 208	11·091147	8·910285	8 209	11·089715	10·001432	18 3	9·998568	24	21
30	38	8·909629	9 234	11·090371	8·911066	9 236	11·088934	10·001437	19 3	9·998563	22	30
40	40	8·910404	10 260	11·089596	8·911846	10 262	11·088154	10·001442	20 3	9·998558	20	20
30	42	8·911177	1 26	11·088823	8·912624	1 26	11·087376	10·001447	21 4	9·998553	18	30
41	44	8·911949	2 51	11·088051	8·913401	2 51	11·086599	10·001452	22 4	9·998548	16	19
30	46	8·912719	3 77	11·087281	8·914177	3 77	11·085823	10·001458	23 4	9·998542	14	30
42	48	8·913488	4 102	11·086512	8·914951	4 103	11·085049	10·001463	24 4	9·998537	12	18
30	50	8·914256	5 128	11·085744	8·915724	5 129	11·084276	10·001468	25 4	9·998532	10	30
43	52	8·915022	6 153	11·084978	8·916495	6 154	11·083505	10·001473	26 4	9·998527	8	17
30	54	8·915787	7 179	11·084213	8·917265	7 180	11·082735	10·001478	27 5	9·998522	6	30
44	56	8·916550	8 204	11·083450	8·918034	8 206	11·081966	10·001484	28 5	9·998516	4	16
30	58	8·917313	9 230	11·082687	8·918801	9 231	11·081199	10·001489	29 5	9·998511	2	30
45	**19**	8·918073	10 255	11·081927	8·919568	10 257	11·080432	10·001494	30 5	9·998506	**41**	15
30	2	8·918833	1 25	11·081167	8·920332	1 25	11·079668	10·001499	1 0	9·998501	58	30
46	4	8·919591	2 50	11·080409	8·921096	2 51	11·078904	10·001505	2 0	9·998495	56	14
30	6	8·920348	3 75	11·079652	8·921858	3 76	11·078142	10·001510	3 1	9·998490	54	30
47	8	8·921103	4 100	11·078897	8·922619	4 101	11·077381	10·001515	4 1	9·998485	52	13
30	10	8·921858	5 125	11·078142	8·923378	5 126	11·076622	10·001521	5 1	9·998479	50	30
48	12	8·922610	6 150	11·077390	8·924136	6 152	11·075864	10·001526	6 1	9·998474	48	12
30	14	8·923362	7 175	11·076638	8·924893	7 177	11·075107	10·001531	7 1	9·998469	46	30
49	16	8·924112	8 201	11·075888	8·925649	8 202	11·074351	10·001536	8 1	9·998464	44	11
30	18	8·924861	9 226	11·075139	8·926403	9 227	11·073597	10·001542	9 2	9·998458	42	30
50	20	8·925609	10 251	11·074391	8·927156	10 253	11·072844	10·001547	10 2	9·998453	40	10
30	22	8·926355	1 25	11·073645	8·927908	1 25	11·072092	10·001552	11 2	9·998448	38	30
51	24	8·927100	2 49	11·072900	8·928658	2 50	11·071342	10·001558	12 2	9·998442	36	9
30	26	8·927844	3 74	11·072156	8·929407	3 74	11·070593	10·001563	13 2	9·998437	34	30
52	28	8·928587	4 99	11·071413	8·930155	4 99	11·069845	10·001569	14 3	9·998431	32	8
30	30	8·929328	5 123	11·070672	8·930902	5 124	11·069098	10·001574	15 3	9·998426	30	30
53	32	8·930068	6 148	11·069932	8·931647	6 149	11·068353	10·001579	16 3	9·998421	28	7
30	34	8·930806	7 173	11·069194	8·932391	7 174	11·067609	10·001585	17 3	9·998415	26	30
54	36	8·931544	8 197	11·068456	8·933134	8 199	11·066866	10·001590	18 3	9·998410	24	6
30	38	8·932280	9 222	11·067720	8·933876	9 223	11·066124	10·001596	19 3	9·998404	22	30
55	40	8·933015	10 247	11·066985	8·934616	10 248	11·065384	10·001601	20 4	9·998399	20	5
30	42	8·933749	1 24	11·066251	8·935355	1 24	11·064645	10·001606	21 4	9·998394	18	30
56	44	8·934481	2 48	11·065519	8·936093	2 49	11·063907	10·001612	22 4	9·998388	16	4
30	46	8·935212	3 73	11·064788	8·936830	3 73	11·063170	10·001617	23 4	9·998383	14	30
57	48	8·935942	4 97	11·064058	8·937565	4 98	11·062435	10·001623	24 4	9·998377	12	3
30	50	8·936671	5 121	11·063329	8·938299	5 122	11·061701	10·001628	25 4	9·998372	10	30
58	52	8·937398	6 145	11·062602	8·939032	6 147	11·060968	10·001634	26 5	9·998366	8	2
30	54	8·938125	7 170	11·061875	8·939764	7 171	11·060236	10·001639	27 5	9·998361	6	30
59	56	8·938850	8 194	11·061150	8·940494	8 195	11·059506	10·001645	28 5	9·998355	4	1
30	58	8·939573	9 218	11·060427	8·941224	9 220	11·058776	10·001650	29 5	9·998350	2	30
60	**20**	8·940296	10 242	11·059704	8·941952	10 244	11·058048	10·001656	30 5	9·998344	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

85° 5h 40m

LOG. SINES, COSINES, &c.

0h 20m — 5°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	8·940296		11·059704	8·941952		11·058048	10·001656		9·998344	**40**	60
30	2	8·941017	1″ 24	11·058983	8·942679	1″ 24	11·057321	10·001660	1″ 0	9·998339	58	30
1	4	8·941738	2 48	11·058262	8·943404	2 48	11·056596	10·001667	2 0	9·998333	56	59
30	6	8·942457	3 71	11·057543	8·944129	3 72	11·055871	10·001672	3 1	9·998328	54	30
2	8	8·943174	4 95	11·056826	8·944852	4 96	11·055148	10·001678	4 1	9·998322	52	58
30	10	8·943891	5 119	11·056109	8·945574	5 120	11·054426	10·001684	5 1	9·998316	50	30
3	12	8·944606	6 143	11·055394	8·946295	6 144	11·053705	10·001689	6 1	9·998311	48	57
30	14	8·945321	7 167	11·054679	8·947015	7 168	11·052985	10·001695	7 1	9·998305	46	30
4	16	8·946034	8 191	11·053966	8·947734	8 192	11·052266	10·001700	8 2	9·998300	44	56
30	18	8·946745	9 214	11·053255	8·948451	9 216	11·051549	10·001706	9 2	9·998294	42	30
5	20	8·947456	10 238	11·052544	8·949168	10 240	11·050832	10·001711	10 2	9·998289	40	55
30	22	8·948166	1 23	11·051834	8·949883	1 24	11·050117	10·001717	11 2	9·998283	38	30
6	24	8·948874	2 47	11·051126	8·950597	2 47	11·049403	10·001723	12 2	9·998277	36	54
30	26	8·949581	3 70	11·050419	8·951309	3 71	11·048691	10·001728	13 2	9·998272	34	30
7	28	8·950287	4 94	11·049713	8·952021	4 95	11·047979	10·001734	14 3	9·998266	32	53
30	30	8·950992	5 117	11·049008	8·952732	5 118	11·047268	10·001740	15 3	9·998260	30	30
8	32	8·951696	6 141	11·048304	8·953441	6 142	11·046559	10·001745	16 3	9·998255	28	52
30	34	8·952398	7 164	11·047602	8·954149	7 165	11·045851	10·001751	17 3	9·998249	26	30
9	36	8·953100	8 188	11·046900	8·954856	8 189	11·045144	10·001757	18 3	9·998243	24	51
30	38	8·953800	9 211	11·046200	8·955562	9 213	11·044438	10·001762	19 4	9·998238	22	30
10	40	8·954499	10 235	11·045501	8·956267	10 236	11·043733	10·001768	20 4	9·998232	20	50
30	42	8·955197	1 23	11·044803	8·956971	1 23	11·043029	10·001774	21 4	9·998226	18	30
11	44	8·955894	2 46	11·044106	8·957674	2 47	11·042326	10·001780	22 4	9·998220	16	49
30	46	8·956590	3 69	11·043410	8·958375	3 70	11·041625	10·001785	23 4	9·998215	14	30
12	48	8·957284	4 92	11·042716	8·959075	4 93	11·040925	10·001791	24 5	9·998209	12	48
30	50	8·957978	5 115	11·042022	8·959775	5 116	11·040225	10·001797	25 5	9·998203	10	30
13	52	8·958670	6 138	11·041330	8·960473	6 140	11·039527	10·001803	26 5	9·998197	8	47
30	54	8·959362	7 161	11·040638	8·961170	7 163	11·038830	10·001808	27 5	9·998192	6	30
14	56	8·960052	8 185	11·039948	8·961866	8 186	11·038134	10·001814	28 5	9·998186	4	46
30	58	8·960741	9 208	11·039259	8·962561	9 209	11·037439	10·001820	29 6	9·998180	2	30
15	**21**	8·961429	10 231	11·038571	8·963255	10 233	11·036745	10·001826	30 6	9·998174	**39**	45
30	2	8·962116	1 23	11·037884	8·963947	1 23	11·036053	10·001832	1 0	9·998168	58	30
16	4	8·962801	2 45	11·037199	8·964639	2 46	11·035361	10·001837	2 0	9·998163	56	44
30	6	8·963486	3 68	11·036514	8·965329	3 69	11·034671	10·001843	3 1	9·998157	54	30
17	8	8·964170	4 91	11·035830	8·966019	4 92	11·033981	10·001849	4 1	9·998151	52	43
30	10	8·964852	5 114	11·035148	8·966707	5 115	11·033293	10·001855	5 1	9·998145	50	30
18	12	8·965534	6 136	11·034466	8·967394	6 137	11·032606	10·001861	6 1	9·998139	48	42
30	14	8·966214	7 159	11·033786	8·968081	7 160	11·031919	10·001867	7 1	9·998133	46	30
19	16	8·966893	8 182	11·033107	8·968766	8 183	11·031234	10·001872	8 2	9·998128	44	41
30	18	8·967572	9 205	11·032428	8·969450	9 206	11·030550	10·001878	9 2	9·998122	42	30
20	20	8·968249	10 227	11·031751	8·970133	10 229	11·029867	10·001884	10 2	9·998116	40	40
30	22	8·968925	1 22	11·031075	8·970815	1 23	11·029185	10·001890	11 2	9·998110	38	30
21	24	8·969600	2 45	11·030400	8·971496	2 45	11·028504	10·001896	12 2	9·998104	36	39
30	26	8·970274	3 67	11·029726	8·972176	3 68	11·027824	10·001902	13 3	9·998098	34	30
22	28	8·970947	4 89	11·029053	8·972855	4 90	11·027145	10·001908	14 3	9·998092	32	38
30	30	8·971619	5 112	11·028381	8·973532	5 113	11·026468	10·001914	15 3	9·998086	30	30
23	32	8·972289	6 134	11·027711	8·974209	6 135	11·025791	10·001920	16 3	9·998080	28	37
30	34	8·972959	7 156	11·027041	8·974885	7 158	11·025115	10·001926	17 3	9·998074	26	30
24	36	8·973628	8 179	11·026372	8·975560	8 180	11·024440	10·001932	18 4	9·998068	24	36
30	38	8·974296	9 201	11·025704	8·976233	9 203	11·023767	10·001938	19 4	9·998062	22	30
25	40	8·974962	10 223	11·025038	8·976906	10 226	11·023094	10·001944	20 4	9·998056	20	35
30	42	8·975628	1 22	11·024372	8·977578	1 22	11·022422	10·001950	21 4	9·998050	18	30
26	44	8·976293	2 44	11·023707	8·978248	2 44	11·021752	10·001956	22 5	9·998044	16	34
30	46	8·976956	3 66	11·023044	8·978918	3 67	11·021082	10·001962	23 5	9·998038	14	30
27	48	8·977619	4 88	11·022381	8·979586	4 89	11·020414	10·001968	24 5	9·998032	12	33
30	50	8·978280	5 110	11·021720	8·980254	5 111	11·019746	10·001974	25 5	9·998026	10	30
28	52	8·978941	6 132	11·021059	8·980921	6 133	11·019079	10·001980	26 5	9·998020	8	32
30	54	8·979600	7 154	11·020400	8·981586	7 156	11·018414	10·001986	27 5	9·998014	6	30
29	56	8·980259	8 176	11·019741	8·982251	8 178	11·017749	10·001992	28 6	9·998008	4	31
30	58	8·980916	9 198	11·019084	8·982914	9 200	11·017086	10·001998	29 6	9·998002	2	30
30	**22**	8·981573	10 220	11·018427	8·983577	10 222	11·016423	10·002004	30 6	9·997996	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

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LOG. SINES, COSINES, &c.

$0^h\ 22^m$ 5°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
30	0	8·981573		11·018427	8·983577		11·016423	10·002004		9·997996	**38**	30
30	2	8·982228	1″ 22	11·017772	8·984238	1″ 22	11·015762	10·002010	1″ 0	9·997990	58	30
31	4	8·982883	2 43	11·017117	8·984899	2 44	11·015101	10·002016	2 0	9·997984	56	29
30	6	8·983536	3 65	11·016464	8·985559	3 66	11·014441	10·002022	3 1	9·997978	54	30
32	8	8·984189	4 87	11·015811	8·986217	4 88	11·013783	10·002028	4 1	9·997972	52	28
30	10	8·984840	5 109	11·015160	8·986875	5 110	11·013125	10·002035	5 1	9·997965	50	30
33	12	8·985491	6 130	11·014509	8·987532	6 131	11·012468	10·002041	6 1	9·997959	48	27
30	14	8·986141	7 152	11·013859	8·988187	7 153	11·011813	10·002047	7 1	9·997953	46	30
34	16	8·986789	8 174	11·013211	8·988842	8 175	11·011158	10·002053	8 2	9·997947	44	26
30	18	8·987437	9 195	11·012563	8·989496	9 197	11·010504	10·002059	9 2	9·997941	42	30
35	20	8·988083	10 217	11·011917	8·990149	10 219	11·009851	10·002065	10 2	9·997935	40	25
30	22	8·988729	1 21	11·011271	8·990801	1 22	11·009199	10·002071	11 2	9·997929	38	30
36	24	8·989374	2 43	11·010626	8·991451	2 43	11·008549	10·002078	12 2	9·997922	36	24
30	26	8·990017	3 64	11·009983	8·992101	3 65	11·007899	10·002084	13 3	9·997916	34	30
37	28	8·990660	4 85	11·009340	8·992750	4 86	11·007250	10·002090	14 3	9·997910	32	23
30	30	8·991302	5 107	11·008698	8·993398	5 108	11·006602	10·002096	15 3	9·997904	30	30
38	32	8·991943	6 128	11·008057	8·994045	6 129	11·005955	10·002103	16 3	9·997897	28	22
30	34	8·992583	7 150	11·007417	8·994692	7 151	11·005308	10·002109	17 4	9·997891	26	30
39	36	8·993222	8 171	11·006778	8·995337	8 173	11·004663	10·002115	18 4	9·997885	24	21
30	38	8·993860	9 192	11·006140	8·995981	9 194	11·004019	10·002121	19 4	9·997879	22	30
40	40	8·994497	10 214	11·005503	8·996624	10 216	11·003376	10·002128	20 4	9·997872	20	20
30	42	8·995133	1 21	11·004867	8·997267	1 21	11·002733	10·002134	21 4	9·997866	18	30
41	44	8·995768	2 42	11·004232	8·997908	2 43	11·002092	10·002140	22 5	9·997860	16	19
30	46	8·996402	3 63	11·003598	8·998549	3 64	11·001451	10·002146	23 5	9·997854	14	30
42	48	8·997036	4 84	11·002964	8·999188	4 85	11·000812	10·002153	24 5	9·997847	12	18
30	50	8·997668	5 105	11·002332	8·999827	5 106	11·000173	10·002159	25 5	9·997841	10	30
43	52	8·998299	6 126	11·001701	9·000465	6 128	10·999535	10·002165	26 5	9·997835	8	17
30	54	8·998930	7 147	11·001070	9·001102	7 149	10·998898	10·002172	27 6	9·997828	6	30
44	56	8·999560	8 168	11·000440	9·001738	8 170	10·998262	10·002178	28 6	9·997822	4	16
30	58	9·000188	9 189	10·999812	9·002373	9 191	10·997627	10·002184	29 6	9·997816	2	30
45	**23**	9·000816	10 210	10·999184	9·003007	10 213	10·996993	10·002191	30 6	9·997809	**37**	15
30	2	9·001443	1 21	10·998557	9·003640	1 21	10·996360	10·002197	1 0	9·997803	58	30
46	4	9·002069	2 41	10·997931	9·004272	2 42	10·995728	10·002203	2 0	9·997797	56	14
30	6	9·002694	3 62	10·997306	9·004904	3 63	10·995096	10·002210	3 1	9·997790	54	30
47	8	9·003318	4 83	10·996682	9·005534	4 84	10·994466	10·002216	4 1	9·997784	52	13
30	10	9·003941	5 104	10·996059	9·006164	5 105	10·993836	10·002223	5 1	9·997777	50	30
48	12	9·004563	6 124	10·995437	9·006792	6 126	10·993208	10·002229	6 1	9·997771	48	12
30	14	9·005185	7 145	10·994815	9·007420	7 147	10·992580	10·002235	7 1	9·997765	46	30
49	16	9·005805	8 166	10·994195	9·008047	8 167	10·991953	10·002242	8 2	9·997758	44	11
30	18	9·006425	9 187	10·993575	9·008673	9 188	10·991327	10·002248	9 2	9·997752	42	30
50	20	9·007044	10 207	10·992956	9·009298	10 209	10·990702	10·002255	10 2	9·997745	40	10
30	22	9·007661	1 20	10·992339	9·009923	1 21	10·990077	10·002261	11 2	9·997739	38	30
51	24	9·008278	2 41	10·991722	9·010546	2 41	10·989454	10·002268	12 3	9·997732	36	9
30	26	9·008894	3 61	10·991106	9·011169	3 62	10·988831	10·002274	13 3	9·997726	34	30
52	28	9·009510	4 82	10·990490	9·011790	4 83	10·988210	10·002281	14 3	9·997719	32	8
30	30	9·010124	5 102	10·989876	9·012411	5 103	10·987589	10·002287	15 3	9·997713	30	30
53	32	9·010737	6 123	10·989263	9·013031	6 124	10·986969	10·002294	16 3	9·997706	28	7
30	34	9·011350	7 143	10·988650	9·013650	7 145	10·986350	10·002300	17 4	9·997700	26	30
54	36	9·011962	8 163	10·988038	9·014268	8 165	10·985732	10·002307	18 4	9·997693	24	6
30	38	9·012572	9 184	10·987428	9·014886	9 186	10·985114	10·002313	19 4	9·997687	22	30
55	40	9·013182	10 204	10·986818	9·015502	10 207	10·984498	10·002320	20 4	9·997680	20	5
30	42	9·013791	1 20	10·986209	9·016118	1 20	10·983882	10·002326	21 4	9·997674	18	30
56	44	9·014400	2 40	10·985600	9·016732	2 41	10·983268	10·002333	22 5	9·997667	16	4
30	46	9·015007	3 61	10·984993	9·017346	3 61	10·982654	10·002339	23 5	9·997661	14	30
57	48	9·015613	4 81	10·984387	9·017959	4 81	10·982041	10·002346	24 5	9·997654	12	3
30	50	9·016219	5 101	10·983781	9·018572	5 102	10·981428	10·002353	25 5	9·997647	10	30
58	52	9·016824	6 121	10·983176	9·019183	6 122	10·980817	10·002359	26 5	9·997641	8	2
30	54	9·017428	7 141	10·982572	9·019794	7 143	10·980206	10·002366	27 6	9·997634	6	30
59	56	9·018031	8 161	10·981969	9·020403	8 163	10·979597	10·002372	28 6	9·997628	4	1
30	58	9·018633	9 182	10·981367	9·021012	9 183	10·978988	10·002379	29 6	9·997621	2	30
60	**24**	9·019235	10 202	10·980765	9·021620	10 204	10·978380	10·002386	30 6	9·997614	0	0
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

84° $5^h\ 36^m$

LOG. SINES, COSINES, &c.

0h 24m — 6°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·019235		10·980765	9·021620		10·978380	10·002386		9·997614	36	60
30	2	9·019835	1″ 20	10·980165	9·022227	1″ 20	10·977773	10·002392	1″ 0	9·997608	58	30
1	4	9·020435	2 40	10·979565	9·022834	2 40	10·977166	10·002399	2 0	9·997601	56	59
30	6	9·021034	3 60	10·978966	9·023439	3 60	10·976561	10·002406	3 1	9·997594	54	30
2	8	9·021632	4 79	10·978368	9·024044	4 80	10·975956	10·002412	4 1	9·997588	52	58
30	10	9·022229	5 99	10·977771	9·024648	5 101	10·975352	10·002419	5 1	9·997581	50	30
3	12	9·022825	6 119	10·977175	9·025251	6 121	10·974749	10·002426	6 1	9·997574	48	57
30	14	9·023421	7 139	10·976579	9·025853	7 141	10·974147	10·002432	7 2	9·997568	46	30
4	16	9·024016	8 159	10·975984	9·026455	8 161	10·973545	10·002439	8 2	9·997561	44	56
30	18	9·024610	9 179	10·975390	9·027055	9 181	10·972945	10·002446	9 2	9·997554	42	30
5	20	9·025203	10 199	10·974797	9·027655	10 201	10·972345	10·002453	10 2	9·997547	40	55
30	22	9·025795	1 20	10·974205	9·028254	1 20	10·971746	10·002459	11 2	9·997541	38	30
6	24	9·026386	2 39	10·973614	9·028852	2 40	10·971148	10·002466	12 3	9·997534	36	54
30	26	9·026977	3 59	10·973023	9·029450	3 59	10·970550	10·002473	13 3	9·997527	34	30
7	28	9·027567	4 78	10·972433	9·030046	4 79	10·969954	10·002480	14 3	9·997520	32	53
30	30	9·028156	5 98	10·971844	9·030642	5 99	10·969358	10·002486	15 3	9·997514	30	30
8	32	9·028744	6 118	10·971256	9·031237	6 119	10·968763	10·002493	16 4	9·997507	28	52
30	34	9·029332	7 137	10·970668	9·031831	7 139	10·968169	10·002500	17 4	9·997500	26	30
9	36	9·029918	8 157	10·970082	9·032425	8 159	10·967575	10·002507	18 4	9·997493	24	51
30	38	9·030504	9 176	10·969496	9·033017	9 178	10·966983	10·002513	19 4	9·997487	22	30
10	40	9·031089	10 196	10·968911	9·033609	10 198	10·966391	10·002520	20 5	9·997480	20	50
30	42	9·031673	1 19	10·968327	9·034200	1 20	10·965800	10·002527	21 5	9·997473	18	30
11	44	9·032257	2 39	10·967743	9·034791	2 39	10·965209	10·002534	22 5	9·997466	16	49
30	46	9·032839	3 58	10·967161	9·035380	3 59	10·964620	10·002541	23 5	9·997459	14	30
12	48	9·033421	4 77	10·966579	9·035969	4 78	10·964031	10·002548	24 5	9·997452	12	48
30	50	9·034002	5 97	10·965998	9·036557	5 98	10·963443	10·002555	25 6	9·997445	10	30
13	52	9·034582	6 116	10·965418	9·037144	6 117	10·962856	10·002561	26 6	9·997439	8	47
30	54	9·035162	7 135	10·964838	9·037730	7 137	10·962270	10·002568	27 6	9·997432	6	30
14	56	9·035741	8 155	10·964259	9·038316	8 157	10·961684	10·002575	28 6	9·997425	4	46
30	58	9·036319	9 174	10·963681	9·038901	9 176	10·961099	10·002582	29 7	9·997418	2	30
15	25	9·036896	10 193	10·963104	9·039485	10 196	10·960515	10·002589	30 7	9·997411	35	45
30	2	9·037472	1 19	10·962528	9·040068	1 19	10·959932	10·002596	1 0	9·997404	58	30
16	4	9·038048	2 38	10·961952	9·040651	2 39	10·959349	10·002603	2 0	9·997397	56	44
30	6	9·038623	3 57	10·961377	9·041232	3 58	10·958768	10·002610	3 1	9·997390	54	30
17	8	9·039197	4 76	10·960803	9·041813	4 77	10·958187	10·002617	4 1	9·997383	52	43
30	10	9·039770	5 95	10·960230	9·042394	5 97	10·957606	10·002624	5 1	9·997376	50	30
18	12	9·040342	6 114	10·959658	9·042973	6 116	10·957027	10·002631	6 1	9·997369	48	42
30	14	9·040914	7 133	10·959086	9·043552	7 135	10·956448	10·002638	7 2	9·997362	46	30
19	16	9·041485	8 153	10·958515	9·044130	8 154	10·955870	10·002645	8 2	9·997355	44	41
30	18	9·042055	9 172	10·957945	9·044707	9 174	10·955293	10·002652	9 2	9·997348	42	30
20	20	9·042625	10 191	10·957375	9·045284	10 193	10·954716	10·002659	10 2	9·997341	40	40
30	22	9·043194	1 19	10·956806	9·045859	1 19	10·954141	10·002666	11 3	9·997334	38	30
21	24	9·043762	2 38	10·956238	9·046434	2 38	10·953566	10·002673	12 3	9·997327	36	39
30	26	9·044329	3 56	10·955671	9·047009	3 57	10·952991	10·002680	13 3	9·997320	34	30
22	28	9·044895	4 75	10·955105	9·047582	4 76	10·952418	10·002687	14 3	9·997313	32	38
30	30	9·045461	5 94	10·954539	9·048155	5 95	10·951845	10·002694	15 4	9·997306	30	30
23	32	9·046026	6 113	10·953974	9·048727	6 114	10·951273	10·002701	16 4	9·997299	28	37
30	34	9·046590	7 132	10·953410	9·049298	7 133	10·950702	10·002708	17 4	9·997292	26	30
24	36	9·047154	8 151	10·952846	9·049869	8 153	10·950131	10·002715	18 4	9·997285	24	36
30	38	9·047717	9 169	10·952283	9·050439	9 172	10·949561	10·002722	19 4	9·997278	22	30
25	40	9·048279	10 188	10·951721	9·051008	10 191	10·948992	10·002729	20 5	9·997271	20	35
30	42	9·048840	1 19	10·951160	9·051576	1 19	10·948424	10·002736	21 5	9·997264	18	30
26	44	9·049400	2 37	10·950600	9·052144	2 38	10·947856	10·002743	22 5	9·997257	16	34
30	46	9·049960	3 56	10·950040	9·052711	3 56	10·947289	10·002751	23 5	9·997249	14	30
27	48	9·050519	4 74	10·949481	9·053277	4 75	10·946723	10·002758	24 6	9·997242	12	33
30	50	9·051078	5 93	10·948922	9·053843	5 94	10·946157	10·002765	25 5	9·997235	10	30
28	52	9·051635	6 111	10·948365	9·054407	6 113	10·945593	10·002772	26 6	9·997228	8	32
30	54	9·052192	7 130	10·947808	9·054972	7 132	10·945028	10·002779	27 7	9·997221	6	30
29	56	9·052749	8 149	10·947251	9·055535	8 150	10·944465	10·002786	28 7	9·997214	4	31
30	58	9·053304	9 167	10·946696	9·056098	9 169	10·943902	10·002794	29 7	9·997206	2	30
30	26	9·053859	10 186	10·946141	9·056659	10 188	10·943341	10·002801	30 7	9·997199	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

83° — 5h 34m

LOG. SINES, COSINES, &c.

0h 26m — 6°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
30	0	9·053859		10·946141	9·056659		10·943341	10·002801		9·997199	34	30
30	2	9·054413	1″ 18	10·945587	9·057221	1″ 19	10·942779	10·002808	1″ 0	9·997192	58	30
31	4	9·054966	2 37	10·945034	9·057781	2 37	10·942219	10·002815	2 0	9·997185	56	29
30	6	9·055519	3 55	10·944481	9·058341	3 56	10·941659	10·002822	3 1	9·997178	54	30
32	8	9·056071	4 73	10·943929	9·058900	4 74	10·941100	10·002830	4 1	9·997170	52	28
30	10	9·056622	5 92	10·943378	9·059459	5 93	10·940541	10·002837	5 1	9·997163	50	30
33	12	9·057172	6 110	10·942828	9·060016	6 111	10·939984	10·002844	6 1	9·997156	48	27
30	14	9·057722	7 128	10·942278	9·060573	7 130	10·939427	10·002851	7 2	9·997149	46	30
34	16	9·058271	8 147	10·941729	9·061130	8 149	10·938870	10·002859	8 2	9·997141	44	26
30	18	9·058820	9 165	10·941180	9·061685	9 167	10·938315	10·002866	9 2	9·997134	42	30
35	20	9·059367	10 183	10·940633	9·062240	10 186	10·937760	10·002873	10 2	9·997127	40	25
30	22	9·059914	1 18	10·940086	9·062795	1 18	10·937205	10·002880	11 3	9·997120	38	30
36	24	9·060460	2 36	10·939540	9·063348	2 37	10·936652	10·002888	12 3	9·997112	36	24
30	26	9·061006	3 54	10·938994	9·063901	3 55	10·936099	10·002895	13 3	9·997105	34	30
37	28	9·061551	4 73	10·938449	9·064453	4 73	10·935547	10·002902	14 4	9·997098	32	23
30	30	9·062095	5 91	10·937905	9·065005	5 92	10·934995	10·002910	15 4	9·997090	30	30
38	32	9·062639	6 109	10·937361	9·065556	6 110	10·934444	10·002917	16 4	9·997083	28	22
30	34	9·063181	7 127	10·936819	9·066106	7 129	10·933894	10·002924	17 4	9·997076	26	30
39	36	9·063724	8 145	10·936276	9·066655	8 147	10·933345	10·002932	18 4	9·997068	24	21
30	38	9·064265	9 163	10·935735	9·067204	9 165	10·932796	10·002939	19 4	9·997061	22	30
40	40	9·064806	10 181	10·935194	9·067752	10 184	10·932248	10·002947	20 5	9·997053	20	20
30	42	9·065346	1 18	10·934654	9·068300	1 18	10·931700	10·002954	21 5	9·997046	18	30
41	44	9·065885	2 36	10·934115	9·068846	2 36	10·931154	10·002961	22 5	9·997039	16	19
30	46	9·066424	3 54	10·933576	9·069393	3 54	10·930607	10·002969	23 6	9·997031	14	30
42	48	9·066962	4 72	10·933038	9·069938	4 73	10·930062	10·002976	24 6	9·997024	12	18
30	50	9·067499	5 90	10·932501	9·070483	5 91	10·929517	10·002984	25 6	9·997016	10	30
43	52	9·068036	6 107	10·931964	9·071027	6 109	10·928973	10·002991	26 7	9·997009	8	17
30	54	9·068572	7 125	10·931428	9·071570	7 127	10·928430	10·002998	27 7	9·997002	6	30
44	56	9·069107	8 143	10·930893	9·072113	8 145	10·927887	10·003006	28 7	9·996994	4	16
30	58	9·069642	9 161	10·930358	9·072655	9 163	10·927345	10·003013	29 7	9·996987	2	30
45	27	9·070176	10 179	10·929824	9·073197	10 181	10·926803	10·003021	30 7	9·996979	33	15
30	2	9·070709	1 18	10·929291	9·073738	1 18	10·926262	10·003028	1 0	9·996972	58	30
46	4	9·071242	2 35	10·928758	9·074278	2 36	10·925722	10·003036	2 1	9·996964	56	14
30	6	9·071774	3 53	10·928226	9·074817	3 54	10·925183	10·003043	3 1	9·996957	54	30
47	8	9·072306	4 71	10·927694	9·075356	4 72	10·924644	10·003051	4 1	9·996949	52	13
30	10	9·072836	5 88	10·927164	9·075895	5 90	10·924105	10·003058	5 1	9·996942	50	30
48	12	9·073366	6 106	10·926634	9·076432	6 107	10·923568	10·003066	6 2	9·996934	48	12
30	14	9·073896	7 124	10·926104	9·076969	7 125	10·923031	10·003073	7 2	9·996927	46	30
49	16	9·074424	8 141	10·925576	9·077505	8 143	10·922495	10·003081	8 2	9·996919	44	11
30	18	9·074952	9 159	10·925047	9·078041	9 161	10·921959	10·003089	9 2	9·996911	42	30
50	20	9·075480	10 177	10·924520	9·078576	10 179	10·921424	10·003096	10 3	9·996904	40	10
30	22	9·076007	1 17	10·923993	9·079110	1 18	10·920890	10·003104	11 3	9·996896	38	30
51	24	9·076533	2 35	10·923467	9·079644	2 35	10·920356	10·003111	12 3	9·996889	36	9
30	26	9·077058	3 52	10·922942	9·080177	3 53	10·919823	10·003119	13 3	9·996881	34	30
52	28	9·077583	4 70	10·922417	9·080710	4 71	10·919290	10·003126	14 4	9·996874	32	8
30	30	9·078107	5 87	10·921893	9·081241	5 89	10·918759	10·003134	15 4	9·996866	30	30
53	32	9·078631	6 105	10·921369	9·081773	6 106	10·918227	10·003142	16 4	9·996858	28	7
30	34	9·079154	7 122	10·920846	9·082303	7 124	10·917697	10·003149	17 4	9·996851	26	30
54	36	9·079676	8 140	10·920324	9·082833	8 142	10·917167	10·003157	18 5	9·996843	24	6
30	38	9·080198	9 157	10·919802	9·083362	9 160	10·916638	10·003165	19 5	9·996835	22	30
55	40	9·080719	10 175	10·919281	9·083891	10 177	10·916109	10·003172	20 5	9·996828	20	5
30	42	9·081239	1 17	10·918761	9·084419	1 18	10·915581	10·003180	21 5	9·996820	18	30
56	44	9·081759	2 34	10·918241	9·084947	2 35	10·915053	10·003188	22 6	9·996812	16	4
30	46	9·082278	3 52	10·917722	9·085473	3 53	10·914527	10·003195	23 6	9·996805	14	30
57	48	9·082797	4 69	10·917203	9·086000	4 70	10·914000	10·003203	24 6	9·996797	12	3
30	50	9·083314	5 86	10·916685	9·086525	5 88	10·913475	10·003211	25 6	9·996789	10	30
58	52	9·083832	6 103	10·916168	9·087050	6 105	10·912950	10·003218	26 7	9·996782	8	2
30	54	9·084348	7 121	10·915652	9·087574	7 123	10·912426	10·003226	27 7	9·996774	6	30
59	56	9·084864	8 138	10·915136	9·088098	8 140	10·911902	10·003234	28 7	9·996766	4	1
30	58	9·085380	9 155	10·914620	9·088621	9 158	10·911379	10·003242	29 7	9·996758	2	30
60	28	9·085894	10 172	10·914106	9·089144	10 175	10·910856	10·003249	30 8	9·996751	0	0
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

83° — 5h 32m

LOG. SINES, COSINES, &c.

0h 28m — 7°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
0	0	9·085894		10·914106	9·089144		10·910856	10·003249		9·996751	32	60
30	2	9·086409	1″ 17	10·913591	9·089666	1″ 17	10·910334	10·003257	1″ 0	9·996743	58	30
1	4	9·086922	2 34	10·913078	9·090187	2 35	10·909813	10·003265	2 1	9·996735	56	59
30	6	9·087435	3 51	10·912565	9·090708	3 52	10·909292	10·003273	3 1	9·996727	54	30
2	8	9·087947	4 68	10·912053	9·091228	4 69	10·908772	10·003280	4 1	9·996720	52	58
30	10	9·088459	5 85	10·911541	9·091747	5 87	10·908253	10·003288	5 1	9·996712	50	30
3	12	9·088970	6 102	10·911030	9·092266	6 104	10·907734	10·003296	6 2	9·996704	48	57
30	14	9·089480	7 119	10·910520	9·092784	7 121	10·907216	10·003304	7 2	9·996696	46	30
4	16	9·089990	8 136	10·910010	9·093302	8 138	10·906698	10·003312	8 2	9·996688	44	56
30	18	9·090500	9 153	10·909500	9·093819	9 156	10·906181	10·003320	9 2	9·996681	42	30
5	20	9·091008	10 170	10·908992	9·094336	10 173	10·905664	10·003327	10 3	9·996673	40	55
30	22	9·091516	1 17	10·908484	9·094851	1 17	10·905149	10·003335	11 3	9·996665	38	30
6	24	9·092024	2 34	10·907976	9·095367	2 34	10·904633	10·003343	12 3	9·996657	36	54
30	26	9·092530	3 50	10·907470	9·095881	3 51	10·904119	10·003351	13 3	9·996649	34	30
7	28	9·093037	4 67	10·906963	9·096395	4 68	10·903605	10·003359	14 4	9·996641	32	53
30	30	9·093542	5 84	10·906458	9·096909	5 86	10·903091	10·003367	15 4	9·996633	30	30
8	32	9·094047	6 101	10·905953	9·097422	6 103	10·902578	10·003375	16 4	9·996625	28	52
30	34	9·094552	7 118	10·905448	9·097934	7 120	10·902066	10·003383	17 4	9·996618	26	30
9	36	9·095056	8 135	10·904944	9·098446	8 137	10·901554	10·003390	18 5	9·996610	24	51
30	38	9·095559	9 151	10·904441	9·098957	9 154	10·901043	10·003398	19 5	9·996602	22	30
10	40	9·096062	10 168	10·903938	9·099468	10 171	10·900532	10·003406	20 5	9·996594	20	50
30	42	9·096564	1 17	10·903436	9·099978	1 17	10·900022	10·003414	21 6	9·996586	18	30
11	44	9·097065	2 33	10·902935	9·100487	2 34	10·899513	10·003422	22 6	9·996578	16	49
30	46	9·097566	3 50	10·902434	9·100996	3 51	10·899004	10·003430	23 6	9·996570	14	30
12	48	9·098066	4 67	10·901934	9·101504	4 68	10·898496	10·003438	24 6	9·996562	12	48
30	50	9·098566	5 83	10·901434	9·102012	5 85	10·897988	10·003446	25 7	9·996554	10	30
13	52	9·099065	6 100	10·900935	9·102519	6 101	10·897481	10·003454	26 7	9·996546	8	47
30	54	9·099564	7 116	10·900436	9·103026	7 118	10·896974	10·003462	27 7	9·996538	6	30
14	56	9·100062	8 133	10·899938	9·103532	8 135	10·896468	10·003470	28 7	9·996530	4	46
30	58	9·100559	9 150	10·899441	9·104037	9 152	10·895963	10·003478	29 8	9·996522	2	30
15	**29**	9·101056	10 166	10·898944	9·104542	10 169	10·895458	10·003486	30 8	9·996514	**31**	45
30	2	9·101552	1 16	10·898448	9·105046	1 17	10·894954	10·003494	1 0	9·996506	58	30
16	4	9·102048	2 33	10·897952	9·105550	2 33	10·894450	10·003502	2 1	9·996498	56	44
30	6	9·102543	3 49	10·897457	9·106053	3 50	10·893947	10·003510	3 1	9·996490	54	30
17	8	9·103037	4 66	10·896963	9·106556	4 67	10·893444	10·003518	4 1	9·996482	52	43
30	10	9·103531	5 82	10·896469	9·107058	5 84	10·892942	10·003527	5 1	9·996474	50	30
18	12	9·104025	6 99	10·895975	9·107559	6 100	10·892441	10·003535	6 2	9·996465	48	42
30	14	9·104517	7 115	10·895483	9·108060	7 117	10·891940	10·003543	7 2	9·996457	46	30
19	16	9·105010	8 132	10·894990	9·108560	8 134	10·891440	10·003551	8 2	9·996449	44	41
30	18	9·105501	9 148	10·894499	9·109060	9 150	10·890940	10·003559	9 2	9·996441	42	30
20	20	9·105992	10 165	10·894008	9·109559	10 167	10·890441	10·003567	10 3	9·996433	40	40
30	22	9·106483	1 16	10·893517	9·110058	1 17	10·889942	10·003575	11 3	9·996425	38	30
21	24	9·106973	2 33	10·893027	9·110556	2 33	10·889444	10·003583	12 3	9·996417	36	39
30	26	9·107462	3 49	10·892538	9·111054	3 50	10·888946	10·003591	13 4	9·996409	34	30
22	28	9·107951	4 65	10·892049	9·111551	4 66	10·888449	10·003600	14 4	9·996400	32	38
30	30	9·108439	5 81	10·891561	9·112047	5 83	10·887953	10·003608	15 4	9·996392	30	30
23	32	9·108927	6 98	10·891073	9·112543	6 99	10·887457	10·003616	16 4	9·996384	28	37
30	34	9·109414	7 114	10·890586	9·113039	7 116	10·886961	10·003624	17 5	9·996376	26	30
24	36	9·109901	8 130	10·890099	9·113533	8 132	10·886467	10·003632	18 5	9·996368	24	36
30	38	9·110387	9 146	10·889613	9·114028	9 149	10·885972	10·003641	19 5	9·996359	22	30
25	40	9·110873	10 163	10·889127	9·114521	10 165	10·885479	10·003649	20 5	9·996351	20	35
30	42	9·111358	1 16	10·888642	9·115015	1 16	10·884985	10·003657	21 6	9·996343	18	30
26	44	9·111842	2 32	10·888158	9·115507	2 33	10·884493	10·003665	22 6	9·996335	16	34
30	46	9·112326	3 48	10·887674	9·115999	3 49	10·884001	10·003674	23 6	9·996327	14	30
27	48	9·112809	4 64	10·887191	9·116491	4 65	10·883509	10·003682	24 7	9·996318	12	33
30	50	9·113292	5 80	10·886708	9·116982	5 82	10·883018	10·003690	25 7	9·996310	10	30
28	52	9·113774	6 96	10·886226	9·117472	6 98	10·882528	10·003698	26 7	9·996302	8	32
30	54	9·114256	7 112	10·885744	9·117962	7 114	10·882038	10·003707	27 7	9·996293	6	30
29	56	9·114737	8 129	10·885263	9·118452	8 131	10·881548	10·003715	28 8	9·996285	4	31
30	58	9·115218	9 145	10·884782	9·118941	9 147	10·881059	10·003723	29 8	9·996277	2	30
30	**30**	9·115698	10 161	10·884302	9·119429	10 163	10·880571	10·003731	30 8	9·996269	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

82° — 5h 30m

LOG. SINES, COSINES, &c.

0h 30m — 7°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
30	0	9·115698		10·884302	9·119429		10·880571	10·003731		9·996269	30	30
30	2	9·116177	1″ 16	10·883823	9·119917	1″ 16	10·880083	10·003740	1″ 0	9·996260	58	30
31	4	9·116656	2 32	10·883344	9·120404	2 32	10·879596	10·003748	2 1	9·996252	56	29
30	6	9·117135	3 48	10·882865	9·120891	3 49	10·879109	10·003756	3 1	9·996244	54	30
32	8	9·117613	4 64	10·882387	9·121377	4 65	10·878623	10·003765	4 1	9·996235	52	28
30	10	9·118090	5 80	10·881910	9·121863	5 81	10·878137	10·003773	5 1	9·996227	50	30
33	12	9·118567	6 95	10·881433	9·122348	6 97	10·877652	10·003781	6 2	9·996219	48	27
30	14	9·119043	7 111	10·880957	9·122833	7 113	10·877167	10·003790	7 2	9·996210	46	30
34	16	9·119519	8 127	10·880481	9·123317	8 129	10·876683	10·003798	8 2	9·996202	44	26
30	18	9·119994	9 143	10·880006	9·123801	9 146	10·876199	10·003807	9 3	9·996193	42	30
35	20	9·120469	10 159	10·879531	9·124284	10 162	10·875716	10·003815	10 3	9·996185	40	25
30	22	9·120943	1 16	10·879057	9·124766	1 16	10·875234	10·003823	11 3	9·996177	38	30
36	24	9·121417	2 31	10·878583	9·125249	2 32	10·874751	10·003832	12 3	9·996168	36	24
30	26	9·121890	3 47	10·878110	9·125730	3 48	10·874270	10·003840	13 4	9·996160	34	30
37	28	9·122362	4 63	10·877638	9·126211	4 64	10·873789	10·003849	14 4	9·996151	32	23
30	30	9·122835	5 79	10·877165	9·126692	5 80	10·873308	10·003857	15 4	9·996143	30	30
38	32	9·123306	6 94	10·876694	9·127172	6 96	10·872828	10·003866	16 5	9·996134	28	22
30	34	9·123777	7 110	10·876223	9·127651	7 112	10·872349	10·003874	17 5	9·996126	26	30
39	36	9·124248	8 126	10·875752	9·128130	8 128	10·871870	10·003883	18 5	9·996117	24	21
30	38	9·124718	9 141	10·875282	9·128609	9 144	10·871391	10·003891	19 5	9·996109	22	30
40	40	9·125187	10 157	10·874813	9·129087	10 160	10·870913	10·003900	20 6	9·996100	20	20
30	42	9·125656	1 16	10·874344	9·129564	1 16	10·870436	10·003908	21 6	9·996092	18	30
41	44	9·126125	2 31	10·873875	9·130041	2 32	10·869959	10·003917	22 6	9·996083	16	19
30	46	9·126593	3 47	10·873407	9·130518	3 47	10·869482	10·003925	23 7	9·996075	14	30
42	48	9·127060	4 62	10·872940	9·130994	4 63	10·869006	10·003934	24 7	9·996066	12	18
30	50	9·127527	5 78	10·872473	9·131469	5 79	10·868531	10·003942	25 7	9·996058	10	30
43	52	9·127993	6 93	10·872007	9·131944	6 95	10·868056	10·003951	26 7	9·996049	8	17
30	54	9·128459	7 109	10·871541	9·132419	7 111	10·867581	10·003959	27 8	9·996041	6	30
44	56	9·128925	8 124	10·871075	9·132893	8 127	10·867107	10·003968	28 8	9·996032	4	16
30	58	9·129390	9 140	10·870610	9·133366	9 142	10·866634	10·003977	29 8	9·996023	2	30
45	**31**	9·129854	10 155	10·870146	9·133839	10 158	10·866161	10·003985	30 8	9·996015	**29**	15
30	2	9·130318	1 15	10·869682	9·134312	1 16	10·865688	10·003994	1 0	9·996006	58	30
46	4	9·130781	2 31	10·869219	9·134784	2 31	10·865216	10·004002	2 1	9·995998	56	14
30	6	9·131244	3 46	10·868756	9·135255	3 47	10·864745	10·004011	3 1	9·995989	54	30
47	8	9·131706	4 62	10·868294	9·135726	4 63	10·864274	10·004020	4 1	9·995980	52	13
30	10	9·132168	5 77	10·867832	9·136197	5 78	10·863803	10·004028	5 1	9·995972	50	30
48	12	9·132630	6 92	10·867370	9·136667	6 94	10·863333	10·004037	6 2	9·995963	48	12
30	14	9·133091	7 108	10·866909	9·137136	7 110	10·862864	10·004046	7 2	9·995954	46	30
49	16	9·133551	8 123	10·866449	9·137605	8 125	10·862395	10·004054	8 2	9·995946	44	11
30	18	9·134011	9 139	10·865989	9·138074	9 141	10·861926	10·004063	9 3	9·995937	42	30
50	20	9·134470	10 154	10·865530	9·138542	10 157	10·861458	10·004072	10 3	9·995928	40	10
30	22	9·134929	1 15	10·865071	9·139009	1 16	10·860991	10·004080	11 3	9·995920	38	30
51	24	9·135387	2 30	10·864613	9·139476	2 31	10·860524	10·004089	12 3	9·995911	36	9
30	26	9·135845	3 46	10·864155	9·139943	3 47	10·860057	10·004098	13 4	9·995902	34	30
52	28	9·136303	4 61	10·863697	9·140409	4 62	10·859591	10·004106	14 4	9·995894	32	8
30	30	9·136760	5 76	10·863240	9·140875	5 78	10·859125	10·004115	15 4	9·995885	30	30
53	32	9·137216	6 91	10·862784	9·141340	6 93	10·858660	10·004124	16 5	9·995876	28	7
30	34	9·137672	7 106	10·862328	9·141805	7 109	10·858195	10·004133	17 5	9·995867	26	30
54	36	9·138128	8 122	10·861872	9·142269	8 124	10·857731	10·004141	18 5	9·995859	24	6
30	38	9·138582	9 137	10·861418	9·142733	9 140	10·857267	10·004150	19 6	9·995850	22	30
55	40	9·139037	10 152	10·860963	9·143196	10 155	10·856804	10·004159	20 6	9·995841	20	5
30	42	9·139491	1 15	10·860509	9·143659	1 15	10·856341	10·004168	21 6	9·995832	18	30
56	44	9·139944	2 30	10·860056	9·144121	2 31	10·855879	10·004177	22 6	9·995823	16	4
30	46	9·140398	3 45	10·859602	9·144583	3 46	10·855417	10·004185	23 7	9·995815	14	30
57	48	9·140850	4 60	10·859150	9·145044	4 61	10·854956	10·004194	24 7	9·995806	12	3
30	50	9·141302	5 75	10·858698	9·145505	5 77	10·854495	10·004203	25 7	9·995797	10	30
58	52	9·141754	6 90	10·858246	9·145966	6 92	10·854034	10·004212	26 8	9·995788	8	2
30	54	9·142205	7 105	10·857795	9·146425	7 108	10·853575	10·004221	27 8	9·995779	6	30
59	56	9·142655	8 121	10·857345	9·146885	8 123	10·853115	10·004229	28 8	9·995771	4	1
30	58	9·143106	9 136	10·856894	9·147344	9 138	10·852656	10·004238	29 8	9·995762	2	30
60	**32**	9·143555	10 151	10·856445	9·147803	10 154	10·852197	10·004247	30 9	9·995753	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

82° — 5h 28m

LOG. SINES, COSINES, &c.

0ʰ 32ᵐ — 8°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·143555		10·856445	9·147803		10·852197	10·004247		9·995753	**28**	60
30	2	9·144005	1″ 15	10·855995	9·148261	1″ 15	10·851739	10·004256	1″ 0	9·995744	58	30
1	4	9·144453	2 30	10·855547	9·148718	2 30	10·851282	10·004265	2 1	9·995735	56	59
30	6	9·144902	3 45	10·855098	9·149175	3 46	10·850825	10·004274	3 1	9·995726	54	30
2	8	9·145349	4 59	10·854651	9·149632	4 61	10·850368	10·004283	4 1	9·995717	52	58
30	10	9·145797	5 74	10·854203	9·150088	5 76	10·849912	10·004292	5 1	9·995708	50	30
3	12	9·146243	6 89	10·853757	9·150544	6 91	10·849456	10·004301	6 2	9·995699	48	57
30	14	9·146690	7 104	10·853310	9·151000	7 106	10·849000	10·004310	7 2	9·995690	46	30
4	16	9·147136	8 119	10·852864	9·151454	8 122	10·848546	10·004319	8 2	9·995681	44	56
30	18	9·147581	9 134	10·852419	9·151909	9 137	10·848091	10·004328	9 3	9·995672	42	30
5	20	9·148026	10 149	10·851974	9·152363	10 152	10·847637	10·004336	10 3	9·995664	40	55
30	22	9·148471	1 15	10·851529	9·152816	1 15	10·847184	10·004345	11 3	9·995655	38	30
6	24	9·148915	2 29	10·851085	9·153269	2 30	10·846731	10·004354	12 4	9·995646	36	54
30	26	9·149358	3 44	10·850642	9·153722	3 45	10·846278	10·004363	13 4	9·995637	34	30
7	28	9·149802	4 59	10·850198	9·154174	4 60	10·845826	10·004372	14 4	9·995628	32	53
30	30	9·150244	5 74	10·849756	9·154626	5 75	10·845374	10·004381	15 4	9·995619	30	30
8	32	9·150686	6 88	10·849314	9·155077	6 90	10·844923	10·004390	16 5	9·995610	28	52
30	34	9·151128	7 103	10·848872	9·155528	7 105	10·844472	10·004400	17 5	9·995601	26	30
9	36	9·151569	8 118	10·848431	9·155978	8 120	10·844022	10·004409	18 5	9·995591	24	51
30	38	9·152010	9 133	10·847990	9·156428	9 135	10·843572	10·004418	19 6	9·995582	22	30
10	40	9·152451	10 147	10·847549	9·156877	10 150	10·843123	10·004427	20 6	9·995573	20	50
30	42	9·152891	1 15	10·847109	9·157326	1 15	10·842674	10·004436	21 6	9·995564	18	30
11	44	9·153330	2 29	10·846670	9·157775	2 30	10·842225	10·004445	22 7	9·995555	16	49
30	46	9·153769	3 44	10·846231	9·158223	3 45	10·841777	10·004454	23 7	9·995546	14	30
12	48	9·154208	4 58	10·845792	9·158671	4 60	10·841329	10·004463	24 7	9·995537	12	48
30	50	9·154646	5 73	10·845354	9·159118	5 75	10·840882	10·004472	25 7	9·995528	10	30
13	52	9·155083	6 87	10·844917	9·159565	6 89	10·840435	10·004481	26 8	9·995519	8	47
30	54	9·155521	7 102	10·844479	9·160011	7 104	10·839989	10·004490	27 8	9·995510	6	30
14	56	9·155957	8 117	10·844043	9·160457	8 119	10·839543	10·004499	28 8	9·995501	4	46
30	58	9·156394	9 131	10·843606	9·160902	9 134	10·839098	10·004509	29 9	9·995491	2	30
15	**33**	9·156830	10 146	10·843170	9·161347	10 149	10·838653	10·004518	30 9	9·995482	**27**	45
30	2	9·157265	1 14	10·842735	9·161792	1 15	10·838208	10·004527	1 0	9·995473	58	30
16	4	9·157700	2 29	10·842300	9·162236	2 29	10·837764	10·004536	2 1	9·995464	56	44
30	6	9·158135	3 43	10·841865	9·162680	3 44	10·837320	10·004545	3 1	9·995455	54	30
17	8	9·158569	4 58	10·841431	9·163123	4 59	10·836877	10·004554	4 1	9·995446	52	43
30	10	9·159002	5 72	10·840998	9·163566	5 74	10·836434	10·004564	5 2	9·995436	50	30
18	12	9·159435	6 87	10·840565	9·164008	6 88	10·835992	10·004573	6 2	9·995427	48	42
30	14	9·159868	7 101	10·840132	9·164450	7 103	10·835550	10·004582	7 2	9·995418	46	30
19	16	9·160301	8 115	10·839699	9·164892	8 118	10·835108	10·004591	8 3	9·995409	44	41
30	18	9·160732	9 130	10·839268	9·165333	9 133	10·834667	10·004601	9 3	9·995399	42	30
20	20	9·161164	10 144	10·838836	9·165774	10 147	10·834226	10·004610	10 3	9·995390	40	40
30	22	9·161595	1 14	10·838405	9·166214	1 15	10·833786	10·004619	11 4	9·995381	38	30
21	24	9·162025	2 29	10·837975	9·166654	2 29	10·833346	10·004628	12 4	9·995372	36	39
30	26	9·162456	3 43	10·837544	9·167093	3 44	10·832907	10·004638	13 4	9·995362	34	30
22	28	9·162885	4 57	10·837115	9·167532	4 58	10·832468	10·004647	14 4	9·995353	32	38
30	30	9·163315	5 71	10·836685	9·167971	5 73	10·832029	10·004656	15 5	9·995344	30	30
23	32	9·163743	6 86	10·836257	9·168409	6 88	10·831591	10·004666	16 5	9·995334	28	37
30	34	9·164172	7 100	10·835828	9·168847	7 102	10·831153	10·004675	17 5	9·995325	26	30
24	36	9·164600	8 114	10·835400	9·169284	8 117	10·830716	10·004684	18 6	9·995316	24	36
30	38	9·165027	9 128	10·834973	9·169721	9 131	10·830279	10·004694	19 6	9·995307	22	30
25	40	9·165454	10 143	10·834546	9·170157	10 146	10·829813	10·004703	20 6	9·995297	20	35
30	42	9·165881	1 14	10·834119	9·170593	1 14	10·829407	10·004712	21 7	9·995288	18	30
26	44	9·166307	2 28	10·833693	9·171029	2 29	10·828971	10·004722	22 7	9·995278	16	34
30	46	9·166733	3 42	10·833267	9·171464	3 43	10·828536	10·004731	23 7	9·995269	14	30
27	48	9·167159	4 57	10·832841	9·171899	4 58	10·828101	10·004740	24 7	9·995260	12	33
30	50	9·167584	5 71	10·832416	9·172333	5 72	10·827667	10·004750	25 8	9·995250	10	30
28	52	9·168008	6 85	10·831992	9·172767	6 87	10·827233	10·004759	26 8	9·995241	8	32
30	54	9·168432	7 99	10·831568	9·173201	7 101	10·826799	10·004769	27 8	9·995232	6	30
29	56	9·168856	8 113	10·831144	9·173634	8 116	10·826366	10·004778	28 9	9·995222	4	31
30	58	9·169279	9 127	10·830721	9·174067	9 130	10·825933	10·004787	29 9	9·995213	2	30
30	**34**	9·169702	10 141	10·830298	9·174499	10 145	10·825501	10·004797	30 9	9·995203	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

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′ ″	m. s.	Sine	Parts	Cosec	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
30	0	9·169702		10·830298	9·174499		10·825501	10·004797		9·995203	26	30
30	2	9·170125	1″ 14	10·829875	9·174931	1″ 14	10·825069	10·004806	1″ 0	9·995194	58	30
31	4	9·170547	2 28	10·829453	9·175362	2 29	10·824638	10·004816	2 1	9·995184	56	29
30	6	9·170968	3 42	10·829032	9·175793	3 43	10·824207	10·004825	3 1	9·995175	54	30
32	8	9·171389	4 56	10·828611	9·176224	4 57	10·823776	10·004835	4 1	9·995165	52	28
30	10	9·171810	5 70	10·828190	9·176654	5 72	10·823346	10·004844	5 2	9·995156	50	30
33	12	9·172230	6 84	10·827770	9·177084	6 86	10·822916	10·004854	6 2	9·995146	48	27
30	14	9·172650	7 98	10·827350	9·177513	7 100	10·822487	10·004863	7 2	9·995137	46	30
34	16	9·173070	8 112	10·826930	9·177942	8 115	10·822058	10·004873	8 3	9·995127	44	26
30	18	9·173489	9 126	10·826511	9·178371	9 129	10·821629	10·004882	9 3	9·995118	42	30
35	20	9·173908	10 140	10·826092	9·178799	10 143	10·821201	10·004892	10 3	9·995108	40	25
30	22	9·174326	1 14	10·825674	9·179227	1 14	10·820773	10·004901	11 4	9·995099	38	30
36	24	9·174744	2 28	10·825256	9·179655	2 28	10·820345	10·004911	12 4	9·995089	36	24
30	26	9·175161	3 41	10·824839	9·180082	3 43	10·819918	10·004920	13 4	9·995080	34	30
37	28	9·175578	[illegible] 55	10·824422	9·180508	4 57	10·819492	10·004930	14 4	9·995070	32	23
30	30	9·175995	5 69	10·824005	9·180934	5 71	10·819066	10·004939	15 5	9·995061	30	30
38	32	9·176411	6 83	10·823589	9·181360	6 85	10·818640	10·004949	16 5	9·995051	28	22
30	34	9·176827	7 97	10·823173	9·181786	7 99	10·818214	10·004959	17 5	9·995041	26	30
39	36	9·177242	8 111	10·822758	9·182211	8 114	10·817789	10·004968	18 6	9·995032	24	21
30	38	9·177657	9 124	10·822343	9·182635	9 128	10·817365	10·004978	19 6	9·995022	22	30
40	40	9·178072	10 138	10·821928	9·183059	10 142	10·816941	10·004987	20 6	9·995013	20	20
30	42	9·178486	1 14	10·821514	9·183483	1 14	10·816517	10·004997	21 7	9·995003	18	30
41	44	9·178900	2 27	10·821100	9·183907	2 28	10·816093	10·005007	22 7	9·994993	16	19
30	46	9·179313	3 41	10·820687	9·184330	3 42	10·815670	10·005016	23 7	9·994984	14	30
42	48	9·179726	4 55	10·820274	9·184752	4 56	10·815248	10·005026	24 8	9·994974	12	18
30	50	9·180139	5 69	10·819861	9·185175	5 70	10·814825	10·005036	25 8	9·994964	10	30
43	52	9·180551	6 82	10·819449	9·185597	6 84	10·814403	10·005045	26 8	9·994955	8	17
30	54	9·180963	7 96	10·819037	9·186018	7 98	10·813982	10·005055	27 9	9·994945	6	30
44	56	9·181374	8 110	10·818626	9·186439	8 113	10·813561	10·005065	28 9	9·994935	4	16
30	58	9·181785	9 124	10·818215	9·186860	9 127	10·813140	10·005075	29 9	9·994925	2	30
45	35	9·182196	10 137	10·817804	9·187280	10 141	10·812720	10·005084	30 10	9·994916	25	15
30	2	9·182606	1 14	10·817394	9·187700	1 14	10·812300	10·005094	1 0	9·994906	58	30
46	4	9·183016	2 27	10·816984	9·188120	2 28	10·811880	10·005104	2 1	9·994896	56	14
30	6	9·183425	3 41	10·816575	9·188539	3 42	10·811461	10·005113	3 1	9·994887	54	30
47	8	9·183834	4 54	10·816166	9·188958	4 56	10·811042	10·005123	4 1	9·994877	52	13
30	10	9·184243	5 68	10·815757	9·189376	5 70	10·810624	10·005133	5 2	9·994867	50	30
48	12	9·184651	6 82	10·815349	9·189794	6 84	10·810206	10·005143	6 2	9·994857	48	12
30	14	9·185059	7 95	10·814941	9·190212	7 98	10·809788	10·005153	7 2	9·994847	46	30
49	16	9·185466	8 109	10·814534	9·190629	8 111	10·809371	10·005162	8 3	9·994838	44	11
30	18	9·185874	9 122	10·814126	9·191046	9 125	10·808954	10·005172	9 3	9·994828	42	30
50	20	9·186280	10 136	10·813720	9·191462	10 139	10·808538	10·005182	10 3	9·994818	40	10
30	22	9·186686	1 13	10·813314	9·191878	1 14	10·808122	10·005192	11 4	9·994808	38	30
51	24	9·187092	2 27	10·812908	9·192294	2 28	10·807706	10·005202	12 4	9·994798	36	9
30	26	9·187498	3 40	10·812502	9·192709	3 41	10·807291	10·005211	13 4	9·994789	34	30
52	28	9·187903	4 54	10·812097	9·193124	4 55	10·806876	10·005221	14 5	9·994779	32	8
30	30	9·188308	5 67	10·811692	9·193539	5 69	10·806461	10·005231	15 5	9·994769	30	30
53	32	9·188712	6 81	10·811288	9·193953	6 83	10·806047	10·005241	16 5	9·994759	28	7
30	34	9·189116	7 94	10·810884	9·194367	7 97	10·805633	10·005251	17 6	9·994749	26	30
54	36	9·189519	8 108	10·810481	9·194780	8 110	10·805220	10·005261	18 6	9·994739	24	6
30	38	9·189923	9 121	10·810077	9·195193	9 124	10·804807	10·005271	19 6	9·994729	22	30
55	40	9·190325	10 135	10·809675	9·195606	10 138	10·804394	10·005280	20 7	9·994720	20	5
30	42	9·190728	1 13	10·809272	9·196018	1 14	10·803982	10·005290	21 7	9·994710	18	30
56	44	9·191130	2 27	10·808870	9·196430	2 27	10·803570	10·005300	22 7	9·994700	16	4
30	46	9·191532	3 40	10·808468	9·196842	3 41	10·803158	10·005310	23 8	9·994690	14	30
57	48	9·191933	4 53	10·808067	9·197253	4 55	10·802747	10·005320	24 8	9·994680	12	3
30	50	9·192334	5 67	10·807666	9·197664	5 68	10·802336	10·005330	25 8	9·994670	10	30
58	52	9·192734	6 80	10·807266	9·198074	6 82	10·801926	10·005340	26 9	9·994660	8	2
30	54	9·193134	7 93	10·806866	9·198484	7 96	10·801516	10·005350	27 9	9·994650	6	30
59	56	9·193534	8 107	10·806466	9·198894	8 109	10·801106	10·005360	28 9	9·994640	4	1
30	58	9·193933	9 120	10·806067	9·199304	9 123	10·800696	10·005370	29 10	9·994630	2	30
60	36	9·194332	10 133	10·805668	9·199713	10 137	10·800287	10·005380	30 10	9·994620	0	0
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

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′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·194332		10·805668	9·199713		10·800287	10·005380		9·994620	**24**	60
30	2	9·194731	1″ 13	10·805269	9·200121	1″ 13	10·799879	10·005390	1″ 0	9·994610	58	30
1	4	9·195129	2 26	10·804871	9·200529	2 27	10·799471	10·005400	2 1	9·994600	56	59
30	6	9·195527	3 39	10·804473	9·200937	3 40	10·799063	10·005410	3 1	9·994590	54	30
2	8	9·195925	4 52	10·804075	9·201345	4 54	10·798655	10·005420	4 1	9·994580	52	58
30	10	9·196322	5 65	10·803678	9·201752	5 67	10·798248	10·005430	5 2	9·994570	50	30
3	12	9·196719	6 79	10·803281	9·202159	6 81	10·797841	10·005440	6 2	9·994560	48	57
30	14	9·197115	7 92	10·802885	9·202565	7 94	10·797435	10·005450	7 2	9·994550	46	30
4	16	9·197511	8 105	10·802489	9·202971	8 108	10·797029	10·005460	8 3	9·994540	44	56
30	18	9·197907	9 118	10·802093	9·203377	9 121	10·796623	10·005470	9 3	9·994530	42	30
5	20	9·198302	10 131	10·801698	9·203782	10 134	10·796218	10·005481	10 3	9·994519	40	55
30	22	9·198697	11 144	10·801303	9·204188	11 148	10·795812	10·005491	11 4	9·994509	38	30
6	24	9·199091	12 157	10·800909	9·204592	12 161	10·795408	10·005501	12 4	9·994499	36	54
30	26	9·199486	13 170	10·800514	9·204996	13 175	10·795004	10·005511	13 4	9·994489	34	30
7	28	9·199879	14 183	10·800121	9·205400	14 188	10·794600	10·005521	14 5	9·994479	32	53
30	30	9·200273	15 197	10·799727	9·205804	15 201	10·794196	10·005531	15 5	9·994469	30	30
8	32	9·200666	16 210	10·799334	9·206207	16 215	10·793793	10·005541	16 5	9·994459	28	52
30	34	9·201059	17 223	10·798941	9·206610	17 229	10·793390	10·005552	17 6	9·994448	26	30
9	36	9·201451	18 236	10·798549	9·207013	18 242	10·792987	10·005562	18 6	9·994438	24	51
30	38	9·201843	19 249	10·798157	9·207415	19 255	10·792585	10·005572	19 6	9·994428	22	30
10	40	9·202234	20 262	10·797766	9·207817	20 269	10·792183	10·005582	20 7	9·994418	20	50
30	42	9·202626	21 275	10·797374	9·208218	21 282	10·791782	10·005592	21 7	9·994408	18	30
11	44	9·203017	22 288	10·796983	9·208619	22 295	10·791381	10·005602	22 7	9·994398	16	49
30	46	9·203407	23 301	10·796593	9·209020	23 309	10·790980	10·005613	23 8	9·994387	14	30
12	48	9·203797	24 315	10·796203	9·209420	24 323	10·790580	10·005623	24 8	9·994377	12	48
30	50	9·204187	25 328	10·795813	9·209820	25 336	10·790180	10·005633	25 8	9·994367	10	30
13	52	9·204577	26 341	10·795423	9·210220	26 350	10·789780	10·005643	26 9	9·994357	8	47
30	54	9·204966	27 354	10·795034	9·210619	27 363	10·789381	10·005654	27 9	9·994346	6	30
14	56	9·205354	28 367	10·794646	9·211018	28 376	10·788982	10·005664	28 9	9·994336	4	46
30	58	9·205743	29 380	10·794257	9·211417	29 390	10·788583	10·005674	29 10	9·994326	2	30
15	**37**	9·206131	30 393	10·793869	9·211815	30 403	10·788185	10·005684	30 10	9·994316	**23**	45
30	2	9·206519	1 13	10·793481	9·212213	1 13	10·787787	10·005695	1 0	9·994305	58	30
16	4	9·206906	2 25	10·793094	9·212611	2 26	10·787389	10·005705	2 1	9·994295	56	44
30	6	9·207293	3 38	10·792707	9·213008	3 39	10·786992	10·005715	3 1	9·994285	54	30
17	8	9·207679	4 51	10·792321	9·213405	4 52	10·786595	10·005726	4 1	9·994274	52	43
30	10	9·208066	5 64	10·791934	9·213802	5 65	10·786198	10·005736	5 2	9·994264	50	30
18	12	9·208452	6 76	10·791548	9·214198	6 79	10·785802	10·005746	6 2	9·994254	48	42
30	14	9·208837	7 89	10·791163	9·214594	7 92	10·785406	10·005757	7 2	9·994243	46	30
19	16	9·209222	8 102	10·790778	9·214989	8 105	10·785011	10·005767	8 3	9·994233	44	41
30	18	9·209607	9 115	10·790393	9·215385	9 118	10·784615	10·005777	9 3	9·994223	42	30
20	20	9·209992	10 127	10·790008	9·215780	10 131	10·784220	10·005788	10 3	9·994212	40	40
30	22	9·210376	11 140	10·789624	9·216174	11 144	10·783826	10·005798	11 4	9·994202	38	30
21	24	9·210760	12 153	10·789240	9·216568	12 157	10·783432	10·005809	12 4	9·994191	36	39
30	26	9·211143	13 166	10·788857	9·216962	13 170	10·783038	10·005819	13 4	9·994181	34	30
22	28	9·211526	14 178	10·788474	9·217356	14 183	10·782644	10·005829	14 5	9·994171	32	38
30	30	9·211909	15 191	10·788091	9·217749	15 196	10·782251	10·005840	15 5	9·994160	30	30
23	32	9·212291	16 204	10·787709	9·218142	16 210	10·781858	10·005850	16 5	9·994150	28	37
30	34	9·212674	17 217	10·787326	9·218534	17 223	10·781466	10·005861	17 6	9·994139	26	30
24	36	9·213055	18 229	10·786945	9·218926	18 236	10·781074	10·005871	18 6	9·994129	24	36
30	38	9·213437	19 242	10·786563	9·219318	19 249	10·780682	10·005882	19 6	9·994118	22	30
25	40	9·213818	20 255	10·786182	9·219710	20 262	10·780290	10·005892	20 7	9·994108	20	35
30	42	9·214198	21 268	10·785802	9·220101	21 275	10·779899	10·005903	21 7	9·994097	18	30
26	44	9·214579	22 280	10·785421	9·220492	22 288	10·779508	10·005913	22 7	9·994087	16	34
30	46	9·214959	23 293	10·785041	9·220882	23 301	10·779118	10·005924	23 8	9·994076	14	30
27	48	9·215338	24 306	10·784662	9·221272	24 314	10·778728	10·005934	24 8	9·994066	12	33
30	50	9·215718	25 319	10·784282	9·221662	25 327	10·778338	10·005945	25 8	9·994055	10	30
28	52	9·216097	26 331	10·783903	9·222052	26 341	10·777948	10·005955	26 9	9·994045	8	32
30	54	9·216475	27 344	10·783525	9·222441	27 354	10·777559	10·005966	27 9	9·994034	6	30
29	56	9·216854	28 357	10·783146	9·222830	28 367	10·777170	10·005976	28 10	9·994024	4	31
30	58	9·217232	29 370	10·782768	9·223218	29 380	10·776782	10·005987	29 10	9·994013	2	30
30	**38**	9·217609	30 382	10·782391	9·223607	30 393	10·776393	10·005997	30 10	9·994003	0	30
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

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′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
30	0	9·217609		10·782391	9·223607		10·776393	10·005997		9·994003	**22**	30
30	2	9·217987	1″ 12	10·782013	9·223994	1″ 13	10·776006	10·006008	1″ 0	9·993992	58	30
31	4	9·218363	2 25	10·781637	9·224382	2 25	10·775618	10·006018	2 1	9·993982	56	29
30	6	9·218740	3 37	10·781260	9·224769	3 38	10·775231	10·006029	3 1	9·993971	54	30
32	8	9·219116	4 50	10·780884	9·225156	4 51	10·774844	10·006040	4 1	9·993960	52	28
30	10	9·219492	5 62	10·780508	9·225543	5 64	10·774457	10·006050	5 2	9·993950	50	30
33	12	9·219868	6 74	10·780132	9·225929	6 77	10·774071	10·006061	6 2	9·993939	48	27
30	14	9·220243	7 87	10·779757	9·226315	7 90	10·773685	10·006072	7 2	9·993928	46	30
34	16	9·220618	8 99	10·779382	9·226700	8 102	10·773300	10·006082	8 3	9·993918	44	26
30	18	9·220993	9 112	10·779007	9·227086	9 115	10·772914	10·006093	9 3	9·993907	42	30
35	20	9·221367	10 124	10·778633	9·227471	10 128	10·772529	10·006103	10 4	9·993897	40	25
30	22	9·221741	11 136	10·778259	9·227855	11 140	10·772145	10·006114	11 4	9·993886	38	30
36	24	9·222115	12 149	10·777885	9·228239	12 153	10·771761	10·006125	12 4	9·993875	36	24
30	26	9·222488	13 161	10·777512	9·228623	13 166	10·771377	10·006136	13 5	9·993864	34	30
37	28	9·222861	14 174	10·777139	9·229007	14 179	10·770993	10·006146	14 5	9·993854	32	23
30	30	9·223234	15 186	10·776766	9·229390	15 192	10·770610	10·006157	15 5	9·993843	30	30
38	32	9·223606	16 198	10·776394	9·229773	16 204	10·770227	10·006168	16 6	9·993832	28	22
30	34	9·223978	17 211	10·776022	9·230156	17 217	10·769844	10·006178	17 6	9·993822	26	30
39	36	9·224349	18 223	10·775651	9·230539	18 230	10·769461	10·006189	18 6	9·993811	24	21
30	38	9·224721	19 236	10·775279	9·230921	19 243	10·769079	10·006200	19 7	9·993800	22	30
40	40	9·225092	20 248	10·774908	9·231302	20 255	10·768698	10·006211	20 7	9·993789	20	20
30	42	9·225462	21 261	10·774538	9·231684	21 268	10·768316	10·006221	21 7	9·993779	18	30
41	44	9·225833	22 273	10·774167	9·232065	22 281	10·767935	10·006232	22 8	9·993768	16	19
30	46	9·226203	23 286	10·773797	9·232446	23 294	10·767554	10·006243	23 8	9·993757	14	30
42	48	9·226573	24 298	10·773427	9·232826	24 307	10·767174	10·006254	24 9	9·993746	12	18
30	50	9·226942	25 310	10·773058	9·233206	25 320	10·766794	10·006265	25 9	9·993735	10	30
43	52	9·227311	26 323	10·772689	9·233586	26 332	10·766414	10·006275	26 9	9·993725	8	17
30	54	9·227680	27 335	10·772320	9·233966	27 345	10·766034	10·006286	27 10	9·993714	6	30
44	56	9·228048	28 348	10·771952	9·234345	28 358	10·765655	10·006297	28 10	9·993703	4	16
30	58	9·228416	29 360	10·771584	9·234724	29 371	10·765276	10·006308	29 10	9·993692	2	30
45	**39**	9·228784	30 372	10·771216	9·235103	30 383	10·764897	10·006319	30 11	9·993681	**21**	15
30	2	9·229151	1 12	10·770849	9·235481	1 12	10·764519	10·006330	1 0	9·993670	58	30
46	4	9·229518	2 24	10·770482	9·235859	2 25	10·764141	10·006340	2 1	9·993660	56	14
30	6	9·229885	3 36	10·770115	9·236237	3 37	10·763763	10·006351	3 1	9·993649	54	30
47	8	9·230252	4 48	10·769748	9·236614	4 50	10·763386	10·006362	4 1	9·993638	52	13
30	10	9·230618	5 60	10·769382	9·236991	5 62	10·763009	10·006373	5 2	9·993627	50	30
48	12	9·230984	6 73	10·769016	9·237368	6 75	10·762632	10·006384	6 2	9·993616	48	12
30	14	9·231349	7 85	10·768651	9·237744	7 87	10·762256	10·006395	7 3	9·993605	46	30
49	16	9·231715	8 97	10·768285	9·238120	8 100	10·761880	10·006406	8 3	9·993594	44	11
30	18	9·232079	9 109	10·767921	9·238496	9 112	10·761504	10·006417	9 3	9·993583	42	30
50	20	9·232444	10 121	10·767556	9·238872	10 125	10·761128	10·006428	10 4	9·993572	40	10
30	22	9·232808	11 133	10·767192	9·239247	11 137	10·760753	10·006439	11 4	9·993561	38	30
51	24	9·233172	12 145	10·766828	9·239622	12 150	10·760378	10·006450	12 4	9·993550	36	9
30	26	9·233536	13 157	10·766464	9·239996	13 162	10·760004	10·006461	13 5	9·993539	34	30
52	28	9·233899	14 169	10·766101	9·240371	14 175	10·759629	10·006472	14 5	9·993528	32	8
30	30	9·234262	15 181	10·765738	9·240745	15 187	10·759255	10·006483	15 6	9·993517	30	30
53	32	9·234625	16 193	10·765375	9·241118	16 200	10·758882	10·006494	16 6	9·993506	28	7
30	34	9·234987	17 206	10·765013	9·241492	17 212	10·758508	10·006505	17 7	9·993495	26	30
54	36	9·235349	18 218	10·764651	9·241865	18 224	10·758135	10·006516	18 7	9·993484	24	6
30	38	9·235711	19 230	10·764289	9·242238	19 237	10·757762	10·006527	19 7	9·993473	22	30
55	40	9·236073	20 242	10·763927	9·242610	20 249	10·757390	10·006538	20 7	9·993462	20	5
30	42	9·236434	21 254	10·763566	9·242982	21 261	10·757018	10·006549	21 8	9·993451	18	30
56	44	9·236795	22 266	10·763205	9·243354	22 274	10·756646	10·006560	22 8	9·993440	16	4
30	46	9·237155	23 278	10·762845	9·243726	23 286	10·756274	10·006571	23 8	9·993429	14	30
57	48	9·237515	24 290	10·762485	9·244097	24 299	10·755903	10·006582	24 9	9·993418	12	3
30	50	9·237875	25 302	10·762125	9·244468	25 311	10·755532	10·006593	25 9	9·993407	10	30
58	52	9·238235	26 314	10·761765	9·244839	26 323	10·755161	10·006604	26 9	9·993396	8	2
30	54	9·238594	27 327	10·761406	9·245209	27 336	10·754791	10·006615	27 10	9·993385	6	30
59	56	9·238953	28 338	10·761047	9·245579	28 348	10·754421	10·006626	28 10	9·993374	4	1
30	58	9·239312	29 351	10·760688	9·245949	29 361	10·754051	10·006637	29 11	9·993363	2	30
60	**40**	9·239670	30 363	10·760330	9·246319	30 374	10·753681	10·006649	30 11	9·993351	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

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$0^h\ 40^m$ 10°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·239670		10·760330	9·246319		10·753681	10·006649		9·993351	**20**	60
30	2	9·240028	1″ 12	10·759972	9·246688	1″ 12	10·753312	10·006660	1″ 0	9·993340	58	30
1	4	9·240386	2 24	10·759614	9·247057	2 24	10·752943	10·006671	2 1	9·993329	56	59
30	6	9·240744	3 35	10·759256	9·247426	3 36	10·752574	10·006682	3 1	9·993318	54	30
2	8	9·241101	4 47	10·758899	9·247794	4 49	10·752206	10·006693	4 2	9·993307	52	58
30	10	9·241458	5 59	10·758542	9·248162	5 61	10·751838	10·006704	5 2	9·993296	50	30
3	12	9·241814	6 71	10·758186	9·248530	6 73	10·751470	10·006716	6 2	9·993284	48	57
30	14	9·242170	7 83	10·757830	9·248897	7 85	10·751103	10·006727	7 3	9·993273	46	30
4	16	9·242526	8 94	10·757474	9·249264	8 97	10·750736	10·006738	8 3	9·993262	44	56
30	18	9·242882	9 106	10·757118	9·249631	9 110	10·750369	10·006749	9 3	9·993251	42	30
5	20	9·243237	10 118	10·756763	9·249998	10 122	10·750002	10·006760	10 4	9·993240	40	55
30	22	9·243592	11 130	10·756408	9·250364	11 134	10·749636	10·006772	11 4	9·993228	38	30
6	24	9·243947	12 141	10·756053	9·250730	12 146	10·749270	10·006783	12 5	9·993217	36	54
30	26	9·244302	13 53	10·755698	9·251096	13 158	10·748904	10·006794	13 5	9·993206	34	30
7	28	9·244656	14 165	10·755344	9·251461	14 170	10·748539	10·006805	14 5	9·993195	32	53
30	30	9·245010	15 177	10·754990	9·251826	15 183	10·748174	10·006817	15 6	9·993183	30	30
8	32	9·245363	16 189	10·754637	9·252191	16 195	10·747809	10·006828	16 6	9·993172	28	52
30	34	9·245717	17 200	10·754283	9·252556	17 207	10·747444	10·006839	17 6	9·993161	26	30
9	36	9·246069	18 212	10·753931	9·252920	18 219	10·747080	10·006851	18 7	9·993149	24	51
30	38	9·246422	19 224	10·753578	9·253284	19 231	10·746716	10·006862	19 7	9·993138	22	30
10	40	9·246775	20 236	10·753225	9·253648	20 243	10·746352	10·006873	20 8	9·993127	20	50
30	42	9·247127	21 248	10·752873	9·254011	21 256	10·745989	10·006885	21 8	9·993115	18	30
11	44	9·247478	22 259	10·752522	9·254374	22 268	10·745626	10·006896	22 8	9·993104	16	49
30	46	9·247830	23 271	10·752170	9·254737	23 280	10·745263	10·006907	23 9	9·993093	14	30
12	48	9·248181	24 283	10·751819	9·255100	24 292	10·744900	10·006919	24 9	9·993081	12	48
30	50	9·248532	25 295	10·751468	9·255462	25 304	10·744538	10·006930	25 9	9·993070	10	30
13	52	9·248883	26 307	10·751117	9·255824	26 316	10·744176	10·006941	26 10	9·993059	8	47
30	54	9·249233	27 318	10·750767	9·256186	27 329	10·743814	10·006953	27 10	9·993047	6	30
14	56	9·249583	28 330	10·750417	9·256547	28 341	10·743453	10·006964	28 11	9·993036	4	46
30	58	9·249933	29 342	10·750067	9·256908	29 353	10·743-92	10·006976	29 11	9·993024	2	30
15	**41**	9·250282	30 354	10·749718	9·257269	30 365	10·742731	10·006987	30 11	9·993013	**19**	45
30	2	9·250631	1″ 11	10·749369	9·257630	1 12	10·742370	10·006998	1 0	9·993002	58	30
16	4	9·250980	2 23	10·749020	9·257990	2 24	10·742010	10·007010	2 1	9·992990	56	44
30	6	9·251329	3 34	10·748671	9·258350	3 36	10·741650	10·007021	3 1	9·992979	54	30
17	8	9·251677	4 46	10·748323	9·258710	4 48	10·741290	10·007033	4 2	9·992967	52	43
30	10	9·252025	5 57	10·747975	9·259069	5 59	10·740931	10·007044	5 2	9·992956	50	30
18	12	9·252373	6 69	10·747627	9·259429	6 71	10·740571	10·007056	6 2	9·992944	48	42
30	14	9·252720	7 80	10·747280	9·259787	7 83	10·740213	10·007067	7 3	9·992933	46	30
19	16	9·253067	8 92	10·746933	9·260146	8 95	10·739854	10·007079	8 3	9·992921	44	41
30	18	9·253414	9 103	10·746586	9·260504	9 107	10·739496	10·007090	9 3	9·992910	42	30
20	20	9·253761	10 115	10·746239	9·260863	10 119	10·739137	10·007102	10 4	9·992898	40	40
30	22	9·254107	11 126	10·745893	9·261220	11 131	10·738780	10·007113	11 4	9·992887	38	30
21	24	9·254453	12 138	10·745547	9·261578	12 143	10·738422	10·007125	12 5	9·992875	36	39
10	26	9·254799	13 149	10·745201	9·261935	13 155	10·738065	10·007136	13 5	9·992864	34	30
22	28	9·255144	14 161	10·744856	9·262292	14 167	10·737708	10·007148	14 5	9·992852	32	38
30	30	9·255490	15 172	10·744510	9·262649	15 178	10·737351	10·007159	15 6	9·992841	30	30
23	32	9·255834	16 184	10·744166	9·263005	16 190	10·736995	10·007171	16 6	9·992829	28	37
30	34	9·256179	17 195	10·743821	9·263361	17 202	10·736639	10·007182	17 6	9·992818	26	30
24	36	9·256523	18 207	10·743477	9·263717	18 214	10·736283	10·007194	18 7	9·992806	24	36
30	38	9·256867	19 218	10·743133	9·264073	19 226	10·735927	10·007206	19 7	9·992794	22	30
25	40	9·257211	20 230	10·742789	9·264428	20 238	10·735572	10·007217	20 8	9·992783	20	35
30	42	9·257554	21 241	10·742446	9·264783	21 250	10·735217	10·007229	21 8	9·992771	18	30
26	44	9·257898	22 253	10·742102	9·265138	22 262	10·734862	10·007241	22 8	9·992759	16	34
30	46	9·258241	23 264	10·741759	9·265493	23 274	10·734507	10·007252	23 9	9·992748	14	30
27	48	9·258583	24 276	10·741417	9·265847	24 285	10·734153	10·007265	24 9	9·992736	12	33
30	50	9·258926	25 287	10·741074	9·266201	25 297	10·733799	10·007276	25 10	9·992724	10	30
28	52	9·259268	26 299	10·740732	9·266555	26 309	10·733445	10·007287	26 10	9·992713	8	32
30	54	9·259609	27 310	10·740391	9·266908	27 321	10·733092	10·007299	27 10	9·992701	0	30
29	56	9·259951	28 322	10·740049	9·267261	28 333	10·732739	10·007310	28 11	9·992690	4	31
30	58	9·260292	29 333	10·739708	9·267614	29 345	10·732386	10·007322	29 11	9·992678	2	30
30	**42**	9·260633	30 345	10·739367	9·267967	30 357	10·732033	10·007334	30 12	9·992666	0	30
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

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′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
30	0	9·260633		10·739367	9·267967		10·732033	10·007334		9·992666	18	30
30	2	9·260974	1″ 11	10·739026	9·268319	1″ 12	10·731681	10·007346	1″ 0	9·992654	58	30
31	4	9·261314	2 22	10·738686	9·268671	2 23	10·731329	10·007357	2 1	9·992643	56	29
30	6	9·261654	3 34	10·738346	9·269023	3 35	10·730977	10·007369	3 1	9·992631	54	30
32	8	9·261994	4 45	10·738006	9·269375	4 46	10·730625	10·007381	4 2	9·992619	52	28
30	10	9·262334	5 56	10·737666	9·269726	5 58	10·730274	10·007393	5 2	9·992607	50	30
33	12	9·262673	6 67	10·737327	9·270077	6 70	10·729923	10·007404	6 2	9·992596	48	27
30	14	9·263012	7 78	10·736988	9·270428	7 81	10·729572	10·007416	7 3	9·992584	46	30
34	16	9·263351	8 90	10·736649	9·270779	8 93	10·729221	10·007428	8 3	9·992572	44	26
30	18	9·263689	9 101	10·736311	9·271129	9 105	10·728871	10·007440	9 4	9·992560	42	30
35	20	9·264027	10 112	10·735973	9·271479	10 116	10·728521	10·007451	10 4	9·992549	40	25
30	22	9·264365	11 123	10·735635	9·271829	11 128	10·728171	10·007463	11 4	9·992537	38	30
36	24	9·264703	12 135	10·735297	9·272178	12 139	10·727822	10·007475	12 5	9·992525	36	24
30	26	9·265040	13 146	10·734960	9·272527	13 151	10·727473	10·007487	13 5	9·992513	34	30
37	28	9·265377	14 157	10·734623	9·272876	14 162	10·727124	10·007499	14 6	9·992501	32	23
30	30	9·265714	15 168	10·734286	9·273225	15 174	10·726775	10·007511	15 6	9·992489	30	30
38	32	9·266051	16 179	10·733949	9·273573	16 186	10·726427	10·007522	16 6	9·992478	28	22
30	34	9·266387	17 191	10·733613	9·273921	17 197	10·726079	10·007534	17 7	9·992466	26	30
39	36	9·266723	18 202	10·733277	9·274269	18 209	10·725731	10·007546	18 7	9·992454	24	21
30	38	9·267059	19 213	10·732941	9·274617	19 221	10·725383	10·007558	19 7	9·992442	22	30
40	40	9·267395	20 224	10·732605	9·274964	20 232	10·725036	10·007570	20 8	9·992430	20	20
30	42	9·267730	21 236	10·732270	9·275312	21 244	10·724688	10·007582	21 8	9·992418	18	30
41	44	9·268065	22 247	10·731935	9·275658	22 256	10·724342	10·007594	22 9	9·992406	16	19
30	46	9·268399	23 258	10·731601	9·276005	23 267	10·723995	10·007606	23 9	9·992394	14	30
42	48	9·268734	24 269	10·731266	9·276351	24 279	10·723649	10·007618	24 9	9·992382	12	18
30	50	9·269068	25 280	10·730932	9·276698	25 290	10·723302	10·007630	25 10	9·992370	10	30
43	52	9·269402	26 292	10·730598	9·277043	26 302	10·722957	10·007641	26 10	9·992359	8	17
30	54	9·269736	27 303	10·730264	9·277389	27 314	10·722611	10·007653	27 11	9·992347	6	30
44	56	9·270069	28 315	10·729931	9·277734	28 325	10·722266	10·007665	28 11	9·992335	4	16
30	58	9·270402	29 326	10·729598	9·278079	29 337	10·721921	10·007677	29 11	9·992323	2	30
45	43	9·270735	30 337	10·729265	9·278424	30 349	10·721576	10·007689	30 12	9·992311	17	15
30	2	9·271067	1 11	10·728933	9·278769	1 11	10·721231	10·007701	1 0	9·992299	58	30
46	4	9·271400	2 22	10·728600	9·279113	2 23	10·720887	10·007713	2 1	9·992287	56	14
30	6	9·271732	3 33	10·728268	9·279457	3 34	10·720543	10·007725	3 1	9·992275	54	30
47	8	9·272064	4 44	10·727936	9·279801	4 45	10·720199	10·007737	4 2	9·992263	52	13
30	10	9·272395	5 55	10·727605	9·280144	5 57	10·719856	10·007749	5 2	9·992251	50	30
48	12	9·272726	6 66	10·727274	9·280488	6 68	10·719512	10·007761	6 2	9·992239	48	12
30	14	9·273057	7 77	10·726943	9·280831	7 79	10·719169	10·007774	7 3	9·992226	46	30
49	16	9·273388	8 88	10·726612	9·281174	8 91	10·718826	10·007786	8 3	9·992214	44	11
30	18	9·273718	9 99	10·726282	9·281516	9 102	10·718484	10·007798	9 4	9·992202	42	30
50	20	9·274049	10 110	10·725951	9·281858	10 114	10·718142	10·007810	10 4	9·992190	40	10
30	22	9·274379	11 121	10·725621	9·282201	11 125	10·717799	10·007822	11 4	9·992178	38	30
51	24	9·274708	12 132	10·725292	9·282542	12 136	10·717458	10·007834	12 5	9·992166	36	9
30	26	9·275038	13 142	10·724962	9·282884	13 148	10·717116	10·007846	13 5	9·992154	34	30
52	28	9·275367	14 153	10·724633	9·283225	14 159	10·716775	10·007858	14 6	9·992142	32	8
30	30	9·275696	15 164	10·724304	9·283566	15 170	10·716434	10·007870	15 6	9·992130	30	30
53	32	9·276025	16 175	10·723975	9·283907	16 182	10·716093	10·007882	16 6	9·992118	28	7
30	34	9·276353	17 186	10·723647	9·284248	17 193	10·715752	10·007895	17 7	9·992105	26	30
54	36	9·276681	18 197	10·723319	9·284588	18 205	10·715412	10·007907	18 7	9·992093	24	6
30	38	9·277009	19 208	10·722991	9·284928	19 216	10·715072	10·007919	19 8	9·992081	22	30
55	40	9·277337	20 219	10·722663	9·285268	20 227	10·714732	10·007931	20 8	9·992069	20	5
30	42	9·277664	21 230	10·722336	9·285607	21 239	10·714393	10·007943	21 8	9·992057	18	30
56	44	9·277991	22 241	10·722009	9·285947	22 250	10·714053	10·007956	22 9	9·992044	16	4
30	46	9·278318	23 252	10·721682	9·286286	23 261	10·713714	10·007968	23 9	9·992032	14	30
57	48	9·278645	24 263	10·721355	9·286624	24 273	10·713376	10·007980	24 10	9·992020	12	3
30	50	9·278971	25 274	10·721029	9·286963	25 284	10·713037	10·007992	25 10	9·992008	10	30
58	52	9·279297	26 285	10·720703	9·287301	26 295	10·712699	10·008004	26 10	9·991996	8	2
30	54	9·279623	27 296	10·720377	9·287639	27 307	10·712361	10·008017	27 11	9·991983	6	30
59	56	9·279948	28 307	10·720052	9·287977	28 318	10·712023	10·008029	28 11	9·991971	4	1
30	58	9·280274	29 318	10·719726	9·288315	29 330	10·711685	10·008041	29 12	9·991959	2	30
60	44	9·280599	30 329	10·719401	9·288652	30 341	10·711348	10·008053	30 12	9·991947	0	0
′ ″	m	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	″

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′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·280599		10·719401	9·288652		10·711348	10·008053		9·991947	**26**	60
30	2	9·280924	1″ 11	10·719076	9·288989	1″ 11	10·711011	10·008066	1″ 0	9·991934	58	30
1	4	9·281248	2 21	10·718752	9·289326	2 22	10·710674	10·008078	2 1	9·991922	56	59
30	6	9·281573	3 32	10·718427	9·289663	3 33	10·710337	10·008090	3 1	9·991910	54	30
2	8	9·281897	4 43	10·718103	9·289999	4 44	10·710001	10·008103	4 2	9·991897	52	58
30	10	9·282220	5 53	10·717780	9·290335	5 56	10·709665	10·008115	5 2	9·901885	50	30
3	12	9·282544	6 64	10·717456	9·290671	6 67	10·709329	10·008127	6 2	9·991873	48	57
30	14	9·282867	7 75	10·717133	9·291007	7 78	10·708993	10·008140	7 3	9·991860	46	30
4	16	9·283190	8 86	10·716810	9·291342	8 89	10·708658	10·008152	8 3	9·991848	44	56
30	18	9·283513	9 96	10·716487	9·291678	9 100	10·708322	10·008164	9 4	9·991836	42	30
5	20	9·283836	10 107	10·716164	9·292013	10 111	10·707987	10·008177	10 4	9·991823	40	55
30	22	9·284158	11 118	10·715842	9·292347	11 122	10·707653	10·008189	11 5	9·991811	38	30
6	24	9·284480	12 128	10·715520	9·292682	12 133	10·707318	10·008201	12 5	9·991799	36	54
30	26	9·284802	13 139	10·715198	9·293016	13 145	10·706984	10·008214	13 5	9·991780	34	30
7	28	9·285124	14 150	10·714876	9·293350	14 156	10·706650	10·008226	14 6	9·991774	32	53
30	30	9·285445	15 160	10·714555	9·293684	15 167	10·706316	10·008239	15 6	9·991761	30	30
8	32	9·285766	16 171	10·714234	9·294017	16 178	10·705983	10·008251	16 7	9·991749	28	52
30	34	9·286087	17 182	10·713913	9·294351	17 189	10·705649	10·008264	17 7	9 991736	26	30
9	36	9·286408	18 193	10·713592	9·294684	18 200	10·705316	10·008276	18 7	9·991724	24	51
30	38	9·286728	19 203	10·713272	9·295016	19 211	10·704984	10·008288	19 8	9·991712	22	30
10	40	9·287048	20 214	10·712952	9·295349	20 222	10·704651	10·008301	20 8	9·991699	20	50
30	42	9·287368	21 225	10·712632	9·295681	21 233	10·7043[illegible]	10·008313	21 9	9·991687	18	30
11	44	9·287688	22 235	10·712312	9·296013	22 245	10·703987	10·008326	22 9	9·991674	16	49
30	46	9·288007	23 246	10·711993	9·296345	23 256	10·703655	10·008338	23 10	9·991662	14	30
12	48	9·288326	24 257	10·711674	9·296677	24 267	10·703323	10·008351	24 10	9·991649	12	48
30	50	9·288645	25 267	10·711355	9·297008	25 278	10·702992	10·008363	25 10	9·991637	10	30
13	52	9·288964	26 278	10·711036	9·297339	26 289	10·702661	10·008376	26 11	9·991624	8	47
30	54	9·289282	27 289	10·710718	9·297670	27 300	10·702330	10·008388	27 11	9·991612	6	30
14	56	9·289600	28 300	10·710400	9·298001	28 311	10·701999	10·008401	28 12	9·991599	4	46
30	58	9·289918	29 310	10·710082	9·298332	29 322	10·701668	10·008414	29 12	9·991586	2	30
15	**45**	9·290236	30 321	10·709764	9·298662	30 334	10·701338	10·008426	30 12	9·991574	**15**	45
30	2	9·290553	1 10	10·709447	9·298992	1 11	10·701008	10·008439	1 0	9·991561	58	30
16	4	9·290870	2 21	10·709130	9·299322	2 22	10·700678	10·008451	2 1	9·991549	56	44
30	6	9·291187	3 31	10·708813	9·299651	3 33	10·700349	10·008464	3 1	9·991536	54	30
17	8	9·291504	4 42	10·708496	9·299980	4 44	10·700020	10·008476	4 2	9·991524	52	43
30	10	9·291820	5 52	10·708180	9·300309	5 54	10·699691	10·008489	5 2	9·991511	50	30
18	12	9·292137	6 63	10·707863	9·300638	6 65	10·699362	10·008502	6 3	9·991498	48	42
30	14	9·292453	7 73	10·707547	9·300967	7 76	10·699033	10·008514	7 3	9·991486	46	30
19	16	9·292768	8 84	10·707232	9·301295	8 87	10·698705	10·008527	8 3	9·991473	44	41
30	18	9·293084	9 94	10·706916	9·301624	9 98	10·698376	10·008540	9 4	9·991460	42	30
20	20	9·293399	10 105	10·706601	9·301951	10 109	10·698049	10·008552	19 4	9·991448	40	40
30	22	9·293714	11 115	10·706286	9·302279	11 120	10·697721	10·008565	11 5	9·991435	38	30
21	24	9·294029	12 126	10·705971	9·302607	12 131	10·697393	10·008578	12 5	9·991422	36	39
30	26	9·294344	13 136	10·705656	9·302934	13 142	10·697066	10·008590	13 6	9·991410	34	30
22	28	9·294658	14 147	10·705342	9·303261	14 153	10·696739	10·008603	14 6	9·991397	32	38
30	30	9·294972	15 157	10·705028	9·303588	15 163	10·696412	10·008616	15 6	9·991384	30	30
23	32	9·295286	16 168	10·704714	9·303914	16 174	10·696086	10·008628	16 7	9·991372	28	37
30	34	9·295600	17 178	10·704400	9·304241	17 185	10·695759	10·008641	17 7	9·991359	26	30
24	36	9·295913	18 188	10·704087	9·304567	18 196	10·695433	10·008654	18 8	9·991346	24	36
30	38	9·296226	19 199	10·703774	9·304893	19 207	10·695107	10·008667	19 8	9·991333	22	30
25	40	9·296539	20 209	10·703461	9·305218	20 218	10·694782	10·008679	20 8	9·991321	20	35
30	42	9·296852	21 220	10·703148	9·305544	21 229	10·694456	10·008692	21 9	9·991308	18	30
26	44	9·297164	22 230	10·702836	9·305869	22 240	10·694131	10·008705	22 9	9·991295	16	34
30	46	9·297476	23 241	10·702524	9·306194	23 251	10·693806	10·008718	23 10	9·991282	14	30
27	48	9·297788	24 251	10·702212	9·306519	24 262	10·693481	10·008730	24 10	9·991270	12	33
30	50	9·298100	25 262	10·701900	9·306843	25 272	10·693157	10·008743	25 11	9·991257	10	30
28	52	9·298412	26 272	10·701588	9·307168	26 283	10·692832	10·008756	26 11	9·991244	8	32
30	54	9·298723	27 283	10·701277	9·307492	27 294	10·692508	10·008769	27 11	9·991231	6	30
29	56	9·299034	28 293	10·700966	9·307816	28 305	10·692184	10·008782	28 12	9·991218	4	31
30	58	9·299345	29 304	10·700655	9·308139	29 316	10·691861	10·008794	29 12	9·991206	2	30
30	**46**	9·299655	30 314	10·700345	9·308463	30 327	10·691537	10·008807	30 13	9·991193	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

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′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
30	0	9·299655		10·700345	9·308463		10·691537	10·008807		9·991193	**14**	30
30	2	9·299966	1″ 10	10·700034	9·308786	1″ 11	10·691214	10·008820	1″ 0	9·991180	58	30
31	4	9·300276	2 21	10·699724	9·309109	2 21	10·690891	10·008833	2 1	9·991167	56	29
30	6	9·300586	3 31	10·699414	9·309432	3 32	10·690568	10·008846	3 1	9·991154	54	30
32	8	9·300895	4 41	10·699105	9·309754	4 43	10·690246	10·008859	4 2	9·991141	52	28
30	10	9·301205	5 51	10·698795	9·310076	5 53	10·689924	10·008872	5 2	9·991128	50	30
33	12	9·301514	6 61	10·698486	9·310399	6 64	10·689601	10·008885	6 3	9·991115	48	27
30	14	9·301823	7 71	10·698177	9·310720	7 75	10·689280	10·008897	7 3	9·991103	46	30
34	16	9·302132	8 82	10·697868	9·311042	8 85	10·688958	10·008910	8 3	9·991090	44	26
30	18	9·302440	9 92	10·697560	9·311364	9 96	10·688636	10·008923	9 4	9·991077	42	30
35	20	9·302748	10 102	10·697252	9·311685	10 107	10·688315	10·008936	10 4	9·991064	40	25
30	22	9·303057	11 113	10·696943	9·312006	11 117	10·687994	10·008949	11 5	9·991051	38	30
36	24	9·303364	12 123	10·696636	9·312327	12 128	10·687673	10·008962	12 5	9·991038	36	24
30	26	9·303672	13 133	10·696328	9·312647	13 139	10·687353	10·008975	13 6	9·991025	34	30
37	28	9·303979	14 143	10·696021	9·312968	14 149	10·687032	10·008988	14 6	9·991012	32	23
30	30	9·304287	15 153	10·695713	9·313288	15 160	10·686712	10·009001	15 6	9·990999	30	30
38	32	9·304593	16 164	10·695407	9·313608	16 171	10·686392	10·009014	16 7	9·990986	28	22
30	34	9·304900	17 174	10·695100	9·313927	17 181	10·686073	10·009027	17 7	9·990973	26	30
39	36	9·305207	18 184	10·694793	9·314247	18 192	10·685753	10·009040	18 8	9·990960	24	21
30	38	9·305513	19 194	10·694487	9·314566	19 203	10·685434	10·009053	19 8	9·990947	22	30
40	40	9·305819	20 205	10·694181	9·314885	20 213	10·685115	10·009066	20 9	9·990934	20	20
30	42	9·306125	21 215	10·693875	9·315204	21 224	10·684796	10·009079	21 9	9·990921	18	30
41	44	9·306430	22 225	10·693570	9·315523	22 235	10·684477	10·009092	22 10	9·990908	16	19
30	46	9·306736	23 235	10·693264	9·315841	23 245	10·684159	10·009105	23 10	9·990895	14	30
42	48	9·307041	24 245	10·692959	9·316159	24 256	10·683841	10·009118	24 10	9·990882	12	18
30	50	9·307346	25 256	10·692654	9·316477	25 267	10·683523	10·009132	25 11	9·990868	10	30
43	52	9·307650	26 266	10·692350	9·316795	26 277	10·683205	10·009145	26 11	9·990855	8	17
30	54	9·307955	27 276	10·692045	9·317113	27 288	10·682887	10·009158	27 12	9·990842	6	30
44	56	9·308259	28 286	10·691741	9·317430	28 299	10·682570	10·009171	28 12	9·990829	4	16
30	58	9·308563	29 297	10·691437	9·317747	29 309	10·682253	10·009184	29 13	9·990816	2	30
45	**47**	9·308867	30 307	10·691133	9·318064	30 320	10·681936	10·009197	30 13	9·990803	**13**	15
30	2	9·309170	1 10	10·690830	9·318381	1 10	10·681619	10·009210	1 0	9·990790	58	30
46	4	9·309474	2 20	10·690526	9·318697	2 21	10·681303	10·009223	2 1	9·990777	56	14
30	6	9·309777	3 30	10·690223	9·319013	3 31	10·680987	10·009237	3 1	9·990763	54	30
47	8	9·310080	4 40	10·689920	9·319330	4 42	10·680670	10·009250	4 2	9·990750	52	13
30	10	9·310382	5 50	10·689618	9·319645	5 52	10·680355	10·009263	5 2	9·990737	50	30
48	12	9·310685	6 60	10·689315	9·319961	6 63	10·680039	10·009276	6 3	9·990724	48	12
30	14	9·310987	7 70	10·689013	9·320277	7 73	10·679723	10·009289	7 3	9·990711	46	30
49	16	9·311289	8 80	10·688711	9·320592	8 84	10·679408	10·009303	8 4	9·990697	44	11
30	18	9·311591	9 90	10·688409	9·320907	9 94	10·679093	10·009316	9 4	9·990684	42	30
50	20	9·311893	10 100	10·688107	9·321222	10 104	10·678778	10·009329	10 4	9·990671	40	10
30	22	9·312194	11 110	10·687806	9·321536	11 115	10·678464	10·009342	11 5	9·990658	38	30
51	24	9·312495	12 120	10·687505	9·321851	12 125	10·678149	10·009355	12 5	9·990645	36	9
30	26	9·312796	13 130	10·687204	9·322165	13 136	10·677835	10·009369	13 6	9·990631	34	30
52	28	9·313097	14 140	10·686903	9·322479	14 146	10·677521	10·009382	14 6	9·990618	32	8
30	30	9·313397	15 150	10·686603	9·322793	15 157	10·677207	10·009395	15 7	9·990605	30	30
53	32	9·313698	16 160	10·686302	9·323106	16 167	10·676894	10·009409	16 7	9·990591	28	7
30	34	9·313998	17 170	10·686002	9·323420	17 178	10·676580	10·009422	17 8	9·990578	26	30
54	36	9·314297	18 180	10·685703	9·323733	18 188	10·676267	10·009435	18 8	9·990565	24	6
30	38	9·314597	19 190	10·685403	9·324046	19 199	10·675954	10·009449	19 8	9·990552	22	30
55	40	9·314897	20 200	10·685103	9·324358	20 209	10·675642	10·009462	20 9	9·990538	20	5
30	42	9·315196	21 210	10·684804	9·324671	21 219	10·675329	10·009475	21 9	9·990525	18	30
56	44	9·315495	22 220	10·684505	9·324983	22 230	10·675017	10·009489	22 10	9·990511	16	4
30	46	9·315793	23 230	10·684207	9·325295	23 240	10·674705	10·009502	23 10	9·990498	14	30
57	48	9·316092	24 240	10·683908	9·325607	24 251	10·674393	10·009515	24 11	9·990485	12	3
30	50	9·316390	25 250	10·683610	9·325919	25 261	10·674081	10·009529	25 11	9·990471	10	30
58	52	9·316689	26 260	10·683311	9·326231	26 272	10·673769	10·009542	26 12	9·990458	8	2
30	54	9·316986	27 270	10·683014	9·326542	27 282	10·673458	10·009555	27 12	9·990445	6	30
59	56	9·317284	28 280	10·682716	9·326853	28 293	10·673147	10·009569	28 12	9·990431	4	1
30	58	9·317582	29 290	10·682418	9·327164	29 303	10·672836	10·009582	29 13	9·990418	2	30
60	**48**	9·317879	30 300	10·682121	9·327475	30 313	10·672525	10·009596	30 13	9·990404	0	0
″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

78° $5^h\ 12^m$

LOG. SINES, COSINES, &c.

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′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·317879		10·682121	9·327475		10·672525	10·009596		9·990404	**12**	60
30	2	9·318176	1″ 10	10·681824	9·327785	1″ 10	10·672215	10·009609	1″ 0	9·990391	58	30
1	4	9·318473	2 20	10·681527	9·328095	2 20	10·671905	10·009622	2 1	9·990378	56	59
30	6	9·318769	3 29	10·681231	9·328405	3 31	10·671595	10·009636	4 1	9·990364	54	30
2	8	9·319066	4 39	10·680934	9·328715	4 41	10·671285	10·009649	4 2	9·990351	52	58
30	10	9·319362	5 49	10·680638	9·329025	5 51	10·670975	10·009663	5 2	9·990337	50	30
3	12	9·319658	6 59	10·680342	9·329334	6 61	10·670666	10·009676	6 3	9·990324	48	57
30	14	9·319954	7 69	10·680046	9·329644	7 72	10·670356	10·009690	7 3	9·990310	46	30
4	16	9·320249	8 78	10·679751	9·329953	8 82	10·670047	10·009703	8 4	9·990297	44	56
30	18	9·320545	9 88	10·679455	9·330262	9 92	10·669738	10·009717	9 4	9·990283	42	30
5	20	9·320840	10 98	10·679160	9·330570	10 102	10·669430	10·009730	10 5	9·990270	40	55
30	22	9·321135	11 108	10·678865	9·330879	11 113	10·669121	10·009744	11 5	9·990256	38	30
6	24	9·321430	12 118	10·678570	9·331187	12 123	10·668813	10·009757	12 5	9·990243	36	54
30	26	9·321724	13 127	10·678276	9·331495	13 133	10·668505	10·009771	13 6	9·990229	34	30
7	28	9·322019	14 137	10·677981	9·331803	14 143	10·668197	10·009785	14 6	9·990215	32	53
30	30	9·322313	15 147	10·677687	9·332111	15 154	10·667889	10·009798	15 7	9·990202	30	30
8	32	9·322607	16 157	10·677393	9·332418	16 164	10·667582	10·009812	16 7	9·990188	28	52
30	34	9·322900	17 167	10·677100	9·332726	17 174	10·667274	10·009825	17 8	9·990175	26	30
9	36	9·323194	18 176	10·676806	9·333033	18 184	10·666967	10·009839	18 8	9·990161	24	51
30	38	9·323487	19 186	10·676513	9·333340	19 195	10·666660	10·009852	19 9	9·990148	22	30
10	40	9·323780	20 196	10·676220	9·333646	20 205	10·666354	10·009866	20 9	9·990134	20	50
30	42	9·324073	21 206	10·675927	9·333953	21 215	10·666047	10·009880	21 9	9·990120	18	30
11	44	9·324366	22 216	10·675634	9·334259	22 225	10·665741	10·009893	22 10	9·990107	16	49
30	46	9·324658	23 225	10·675342	9·334565	23 236	10·665435	10·009907	23 10	9·990093	14	30
12	48	9·324950	24 235	10·675050	9·334871	24 246	10·665129	10·009921	24 11	9·990079	12	48
30	50	9·325243	25 245	10·674757	9·335177	25 256	10·664823	10·009934	25 11	9·990066	10	30
13	52	9·325534	26 255	10·674466	9·335482	26 266	10·664518	10·009948	26 12	9·990052	8	47
30	54	9·325826	27 265	10·674174	9·335788	27 277	10·664212	10·009962	27 12	9·990038	6	30
14	56	9·326117	28 274	10·673883	9·336093	28 287	10·663907	10·009975	28 13	9·990025	4	46
30	58	9·326409	29 284	10·673591	9·336398	29 297	10·663602	10·009989	29 13	9·990011	2	30
15	**49**	9·326700	30 294	10·673300	9·336702	30 307	10·663298	10·010003	30 14	9·989997	**11**	45
30	2	9·326991	1 10	10·673009	9·337007	1 10	10·662993	10·010016	1 0	9·989984	58	30
16	4	9·327281	2 19	10·672719	9·337311	2 20	10·662689	10·010030	2 1	9·989970	56	44
30	6	9·327572	3 29	10·672428	9·337615	3 30	10·662385	10·010044	3 1	9·989956	54	30
17	8	9·327862	4 38	10·672138	9·337919	4 40	10·662081	10·010058	4 2	9·989942	52	43
30	10	9·328152	5 48	10·671848	9·338223	5 50	10·661777	10·010071	5 2	9·989929	50	30
18	12	9·328442	6 58	10·671558	9·338527	6 60	10·661473	10·010085	6 3	9·989915	48	42
30	14	9·328731	7 67	10·671269	9·338830	7 70	10·661170	10·010099	7 3	9·989901	46	30
19	16	9·329021	8 77	10·670979	9·339133	8 80	10·660867	10·010113	8 4	9·989887	44	41
30	18	9·329310	9 86	10·670690	9·339436	9 90	10·660564	10·010127	9 4	9·989873	42	30
20	20	9·329599	10 96	10·670401	9·339739	10 101	10·660261	10·010140	10 5	9·989860	40	40
30	22	9·329888	11 106	10·670112	9·340042	11 111	10·659958	10·010154	11 5	9·989846	38	30
21	24	9·330176	12 115	10·669824	9·340344	12 121	10·659656	10·010168	12 5	9·989832	36	39
30	26	9·330465	13 125	10·669535	9·340646	13 131	10·659354	10·010182	13 6	9·989818	34	30
22	28	9·330753	14 134	10·669247	9·340948	14 141	10·659052	10·010196	14 6	9·989804	32	38
30	30	9·331041	15 144	10·668959	9·341250	15 151	10·658750	10·010210	15 7	9·989790	30	30
23	32	9·331329	16 154	10·668671	9·341552	16 161	10·658448	10·010223	16 7	9·989777	28	37
30	34	9·331616	17 163	10·668384	9·341853	17 171	10·658147	10·010237	17 8	9·989763	26	30
24	36	9·331903	18 173	10·668097	9·342155	18 181	10·657845	10·010251	18 8	9·989749	24	36
30	38	9·332191	19 182	10·667809	9·342456	19 191	10·657544	10·010265	19 9	9·989735	22	30
25	40	9·332478	20 192	10·667522	9·342757	20 201	10·657243	10·010279	20 9	9·989721	20	35
30	42	9·332764	21 202	10·667236	9·343057	21 211	10·656943	10·010293	21 9	9·989707	18	30
26	44	9·333051	22 211	10·666949	9·343358	22 221	10·656642	10·010307	22 10	9·989693	16	34
30	46	9·333337	23 221	10·666663	9·343658	23 231	10·656342	10·010321	23 10	9·989679	14	30
27	48	9·333624	24 230	10·666376	9·343958	24 241	10·656042	10·010335	24 11	9·989665	12	33
30	50	9·333910	25 240	10·666090	9·344258	25 252	10·655742	10·010349	25 11	9·989651	10	30
28	52	9·334195	26 250	10·665805	9·344558	26 262	10·655442	10·010363	26 12	9·989637	8	32
30	54	9·334481	27 259	10·665519	9·344858	27 272	10·655142	10·010377	27 12	9·989623	6	30
29	56	9·334767	28 269	10·665233	9·345157	28 282	10·654843	10·010390	28 13	9·989610	4	31
30	58	9·335052	29 278	10·664948	9·345456	29 292	10·654544	10·010404	29 13	9·989596	2	30
30	**50**	9·335337	30 288	10·664663	9·345755	30 302	10·654245	10·010418	30 14	9·989582	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

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LOG. SINES, COSINES, &c.

0h 50m — 12°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
30	0	9·335337		10·664663	9·345755		10·654245	10·010418		9·989582	**10**	30
30	2	9·335622	1 9	10·664378	9·346054	1″ 10	10·653946	10·010432	1″ 0	9·989568	58	30
31	4	9·335906	2 19	10·664094	9·346353	2 20	10·653647	10·010447	2 1	9·989553	56	29
30	6	9·336191	3 28	10·663809	9·346651	3 30	10·653349	10·010461	3 1	9·989539	54	30
32	8	9·336475	4 38	10·663525	9·346949	4 39	10·653051	10·010475	4 2	9·989525	52	28
30	10	9·336759	5 47	10·663241	9·347248	5 49	10·652752	10·010489	5 2	9·989511	50	30
33	12	9·337043	6 56	10·662957	9·347545	6 59	10·652455	10·010503	6 3	9·989497	48	27
30	14	9·337326	7 66	10·662674	9·347843	7 69	10·652157	10·010517	7 3	9·989483	46	30
34	16	9·337610	8 75	10·662390	9·348141	8 80	10·651859	10·010531	8 4	9·989469	44	26
30	18	9·337893	9 85	10·662107	9·348438	9 89	10·651562	10·010545	9 4	9·989455	42	30
35	20	9·338176	10 94	10·661824	9·348735	10 99	10·651265	10·010559	10 5	9·989441	40	25
30	22	9·338459	11 103	10·661541	9·349032	11 109	10·650968	10·010573	11 5	9·989427	38	30
36	24	9·338742	12 113	10·661258	9·349329	12 118	10·650671	10·010587	12 6	9·989413	36	24
30	26	9·339024	13 122	10·660976	9·349626	13 128	10·650374	10·010601	13 6	9·989399	34	30
37	28	9·339307	14 132	10·660693	9·349922	14 138	10·650078	10·010615	14 7	9·989385	32	23
30	30	9·339589	15 141	10·660411	9·350218	15 148	10·649782	10·010630	15 7	9·989370	30	30
38	32	9·339871	16 150	10·660129	9·350514	16 158	10·649486	10·010644	16 8	9·989356	28	22
30	34	9·340152	17 160	10·659848	9·350810	17 168	10·649190	10·010658	17 8	9·989342	26	30
39	36	9·340434	18 169	10·659566	9·351106	18 178	10·648894	10·010672	18 8	9·989328	24	21
30	38	9·340715	19 179	10·659285	9·351401	19 188	10·648599	10·010686	19 9	9·989314	22	30
40	40	9·340996	20 188	10·659004	9·351697	20 197	10·648303	10·010700	20 9	9·989300	20	20
30	42	9·341277	21 197	10·658723	9·351992	21 207	10·648008	10·010715	21 10	9·989285	18	30
41	44	9·341558	22 207	10·658442	9·352287	22 217	10·647713	10·010729	22 10	9·989271	16	19
30	46	9·341839	23 216	10·658161	9·352582	23 227	10·647418	10·010743	23 11	9·989257	14	30
42	48	9·342119	24 226	10·657881	9·352876	24 237	10·647124	10·010757	24 11	9·989243	12	18
30	50	9·342399	25 235	10·657601	9·353171	25 247	10·646829	10·010772	25 12	9·989228	10	30
43	52	9·342679	26 244	10·657321	9·353465	26 257	10·646535	10·010786	26 12	9·989214	8	17
30	54	9·342959	27 254	10·657041	9·353759	27 266	10·646241	10·010800	27 13	9·989200	6	30
44	56	9·343239	28 263	10·656761	9·354053	28 276	10·645947	10·010814	28 13	9·989186	4	16
30	58	9·343518	29 273	10·656482	9·354347	29 286	10·645653	10·010829	29 14	9·989171	2	30
45	**51**	9·343797	30 282	10·656203	9·354640	30 296	10·645360	10·010843	30 14	9·989157	**9**	15
30	2	9·344076	1 9	10·655924	9·354934	1 10	10·645066	10·010857	1 0	9·989143	58	30
46	4	9·344355	2 18	10·655645	9·355227	2 19	10·644773	10·010872	2 1	9·989128	56	14
30	6	9·344634	3 28	10·655366	9·355520	3 29	10·644480	10·010886	3 1	9·989114	54	30
47	8	9·344912	4 37	10·655088	9·355813	4 39	10·644187	10·010900	4 2	9·989100	52	13
30	10	9·345191	5 46	10·654809	9·356105	5 48	10·643895	10·010915	5 2	9·989085	50	30
48	12	9·345469	6 55	10·654531	9·356398	6 58	10·643602	10·010929	6 3	9·989071	48	12
30	14	9·345747	7 64	10·654253	9·356690	7 68	10·643310	10·010943	7 3	9·989057	46	30
49	16	9·346024	8 73	10·653976	9·356982	8 77	10·643018	10·010958	8 4	9·989042	44	11
30	18	9·346302	9 83	10·653698	9·357274	9 87	10·642726	10·010972	9 4	9·989028	42	30
50	20	9·346579	10 92	10·653421	9·357566	10 97	10·642434	10·010986	10 5	9·989014	40	10
30	22	9·346857	11 101	10·653143	9·357857	11 106	10·642143	10·011001	11 5	9·988999	38	30
51	24	9·347134	12 111	10·652866	9·358149	12 116	10·641851	10·011015	12 6	9·988985	36	9
30	26	9·347410	13 120	10·652590	9·358440	13 126	10·641560	10·011030	13 6	9·988970	34	30
52	28	9·347687	14 129	10·652313	9·358731	14 135	10·641269	10·011044	14 7	9·988956	32	8
30	30	9·347963	15 138	10·652037	9·359022	15 145	10·640978	10·011058	15 7	9·988942	30	30
53	32	9·348240	16 147	10·651760	9·359313	16 155	10·640687	10·011073	16 8	9·988927	28	7
30	34	9·348516	17 157	10·651484	9·359603	17 164	10·640397	10·011087	17 8	9·988913	26	30
54	36	9·348792	18 166	10·651208	9·359893	18 174	10·640107	10·011102	18 9	9·988898	24	6
30	38	9·349067	19 175	10·650933	9·360184	19 184	10·639816	10·011116	19 9	9·988884	22	30
55	40	9·349343	20 184	10·650657	9·360474	20 193	10·639526	10·011131	20 10	9·988869	20	5
30	42	9·349618	21 193	10·650382	9·360763	21 203	10·639237	10·011145	21 10	9·988855	18	30
56	44	9·349893	22 203	10·650107	9·361053	22 213	10·638947	10·011160	22 11	9·988840	16	4
30	46	9·350168	23 212	10·649832	9·361343	23 222	10·638657	10·011174	23 11	9·988826	14	30
57	48	9·350443	24 221	10·649557	9·361632	24 232	10·638368	10·011189	24 12	9·988811	12	3
30	50	9·350718	25 230	10·649282	9·361921	25 242	10·638079	10·011203	25 12	9·988797	10	30
58	52	9·350992	26 239	10·649008	9·362210	26 251	10·637790	10·011218	26 12	9·988782	8	2
30	54	9·351266	27 249	10·648734	9·362499	27 261	10·637501	10·011232	27 13	9·988768	6	30
59	56	9·351540	28 258	10·648460	9·362787	28 271	10·637213	10·011247	28 13	9·988753	4	1
30	58	9·351814	29 267	10·648186	9·363076	29 280	10·636924	10·011261	29 14	9·988739	2	30
60	**52**	9·352088	30 276	10·647912	9·363364	30 290	10·636636	10·011276	30 14	9·988724	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

77° — 5h 8m

LOG. SINES, COSINES, &c.

$0^h\ 52^m$ — 13°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
0	0	9·352088		10·647912	9·363364		10·636636	10·011276		9·988724	8	60
30	2	9·352362	1″ 9	10·647638	9·363652	1″ 10	10·636348	10·011291	1″ 0	9·988709	58	30
1	4	9·352635	2 18	10·647365	9·363940	2 19	10·636060	10·011305	2 1	9·988695	56	59
30	6	9·352908	3 27	10·647092	9·364228	3 29	10·635772	10·011320	3 1	9·988680	54	30
2	8	9·353181	4 36	10·646819	9·364515	4 38	10·635485	10·011334	4 2	9·988666	52	58
30	10	9·353454	5 45	10·646546	9·364803	5 48	10·635197	10·011349	5 2	9·988651	50	30
3	12	9·353726	6 54	10·646274	9·365090	6 57	10·634910	10·011364	6 3	9·988636	48	57
30	14	9·353999	7 63	10·646001	9·365377	7 67	10·634623	10·011378	7 3	9·988622	46	30
4	16	9·354271	8 72	10·645729	9·365664	8 76	10·634336	10·011393	8 4	9·988607	44	56
30	18	9·354543	9 81	10·645457	9·365951	9 86	10·634049	10·011408	9 4	9·988592	42	30
5	20	9·354815	10 90	10·645185	9·366237	10 95	10·633763	10·011422	10 5	9·988578	40	55
30	22	9·355087	11 99	10·644913	9·366524	11 105	10·633476	10·011437	11 5	9·988563	38	30
6	24	9·355358	12 108	10·644642	9·366810	12 114	10·633190	10·011452	12 6	9·988548	36	54
30	26	9·355630	13 117	10·644370	9·367096	13 124	10·632904	10·011466	13 6	9·988534	34	30
7	28	9·355901	14 126	10·644099	9·367382	14 133	10·632618	10·011481	14 7	9·988519	32	53
30	30	9·356172	15 135	10·643828	9·367668	15 143	10·632332	10·011496	15 7	9·988504	30	30
8	32	9·356443	16 144	10·643557	9·367953	16 152	10·632047	10·011511	16 8	9·988489	28	52
30	34	9·356713	17 153	10·643287	9·368239	17 162	10·631761	10·011525	17 8	9·988475	26	30
9	36	9·356984	18 162	10·643016	9·368524	18 171	10·631476	10·011540	18 9	9·988460	24	51
30	38	9·357254	19 171	10·642746	9·368809	19 181	10·631191	10·011555	19 9	9·988445	22	30
10	40	9·357524	20 181	10·642476	9·369094	20 190	10·630906	10·011570	20 10	9·988430	20	50
30	42	9·357794	21 190	10·642206	9·369378	21 200	10·630622	10·011584	21 10	9·988416	18	30
11	44	9·358064	22 199	10·641936	9·369663	22 209	10·630337	10·011599	22 11	9·988401	16	49
30	46	9·358333	23 208	10·641667	9·369947	23 219	10·630053	10·011614	23 11	9·988386	14	30
12	48	9·358603	24 217	10·641397	9·370232	24 228	10·629768	10·011629	24 12	9·988371	12	48
30	50	9·358872	25 226	10·641128	9·370516	25 238	10·629484	10·011644	25 12	9·988356	10	30
13	52	9·359141	26 235	10·640859	9·370799	26 248	10·629201	10·011658	26 13	9·988342	8	47
30	54	9·359410	27 244	10·640590	9·371083	27 257	10·628917	10·011673	27 13	9·988327	6	30
14	56	9·359678	28 253	10·640322	9·371367	28 267	10·628633	10·011688	28 14	9·988312	4	46
30	58	9·359947	29 262	10·640053	9·371650	29 276	10·628350	10·011703	29 14	9·988297	2	30
15	**53**	9·360215	30 271	10·639785	9·371933	30 286	10·628067	10·011718	30 15	9·988282	**7**	45
30	2	9·360484	1 9	10·639516	9·372216	1 10	10·627784	10·011733	1 0	9·988267	58	30
16	4	9·360752	2 18	10·639248	9·372499	2 19	10·627501	0·011748	2 1	9·988252	56	44
30	6	9·361019	3 26	10·638981	9·372782	3 28	10·627218	10·011763	3 1	9·988237	54	30
17	8	9·361287	4 35	10·638713	9·373064	4 37	10·626936	10·011777	4 2	9·988223	52	43
30	10	9·361554	5 44	10·638446	9·373347	5 47	10·626653	10·011792	5 2	9·988208	50	30
18	12	9·361822	6 53	10·638178	9·373629	6 56	10·626371	10·011807	6 3	9·988193	48	42
30	14	9·362089	7 62	10·637911	9·373911	7 65	10·626089	10·011822	7 3	9·988178	46	30
19	16	9·362356	8 70	10·637644	9·374193	8 75	10·625807	10·011837	8 4	9·988163	44	41
30	18	9·362623	9 79	10·637377	9·374475	9 84	10·625525	10·011852	9 4	9·988148	42	30
20	20	9·362889	10 88	10·637111	9·374756	10 93	10·625244	10·011867	10 5	9·988133	40	40
30	22	9·363156	11 97	10·636844	9·375038	11 103	10·624962	10·011882	11 5	9·988118	38	30
21	24	9·363422	12 106	10·636578	9·375319	12 112	10·624681	10·011897	12 6	9·988103	36	39
30	26	9·363688	13 115	10·636312	9·375600	13 122	10·624400	10·011912	13 6	9·988088	34	30
22	28	9·363954	14 124	10·636046	9·375881	14 131	10·624119	10·011927	14 7	9·988073	32	38
30	30	9·364220	15 133	10·635780	9·376162	15 140	10·623838	10·011942	15 7	9·988058	30	30
23	32	9·364485	16 142	10·635515	9·376442	16 150	10·623558	10·011957	16 8	9·988043	28	37
30	34	9·364751	17 151	10·635249	9·376723	17 158	10·623277	10·011972	17 8	9·988028	26	30
24	36	9·365016	18 159	10·634984	9·377003	18 168	10·622997	10·011987	18 9	9·988013	24	36
30	38	9·365281	19 168	10·634719	9·377283	19 178	10·622717	10·012002	19 9	9·987998	22	30
25	40	9·365546	20 177	10·634454	9·377563	20 187	10·622437	10·012017	20 10	9·987983	20	35
30	42	9·365810	21 186	10·634190	9·377843	21 196	10·622157	10·012032	21 10	9·987968	18	30
26	44	9·366075	22 195	10·633925	9·378122	22 206	10·621878	10·012047	22 11	9·987953	16	34
30	46	9·366339	23 203	10·633661	9·378402	23 215	10·621598	10·012063	23 11	9·987937	14	30
27	48	9·366604	24 212	10·633396	9·378681	24 224	10·621319	10·012078	24 12	9·987922	12	33
30	50	9·366868	25 221	10·633132	9·378960	25 234	10·621040	10·012093	25 12	9·987907	10	30
28	52	9·367131	26 230	10·632869	9·379239	26 243	10·620761	10·012108	26 13	9·987892	8	32
30	54	9·367395	27 239	10·632605	9·379518	27 252	10·620482	10·012123	27 13	9·987877	6	30
29	56	9·367659	28 248	10·632341	9·379797	28 262	10·620203	10·012138	28 14	9·987862	4	31
30	58	9·367922	29 257	10·632078	9·380075	29 271	10·619925	10·012153	29 14	9·987847	2	30
30	**54**	9·368185	30 265	10·631815	9·380354	30 280	10·619646	10·012168	30 15	9·987832	0	30
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

76° — $5^h\ 6^m$

LOG. SINES, COSINES, &c.

0ʰ 54ᵐ 13°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
30	0	9·368185		10·631815	9·380354		10·619646	10·012168		9·987832	6	30
30	2	9·368448	1″ 9	10·631552	9·380632	1″ 9	10·619368	10·012184	1″ 1	9·987816	58	30
31	4	9·368711	2 17	10·631289	9·380910	2 18	10·619090	10·012199	2 1	9·987801	56	29
30	6	9·368974	3 26	10·631026	9·381188	3 28	10·618812	10·012214	3 2	9·987786	54	30
32	8	9·369236	4 35	10·630764	9·381466	4 37	10·618534	10·012229	4 2	9·987771	52	28
30	10	9·369499	5 43	10·630501	9·381743	5 46	10·618257	10·012244	5 3	9·987756	50	30
33	12	9·369761	6 52	10·630239	9·382020	6 55	10·617980	10·012260	6 3	9·987740	48	27
30	14	9·370023	7 61	10·629977	9·382298	7 64	10·617702	10·012275	7 4	9·987725	46	30
34	16	9·370285	8 70	10·629715	9·382575	8 74	10·617425	10·012290	8 4	9·987710	44	26
30	18	9·370546	9 78	10·629454	9·382852	9 83	10·617148	10·012305	9 5	9·987695	42	30
35	20	9·370808	10 87	10·629192	9·383129	10 92	10·616871	10·012321	10 5	9·987679	40	25
30	22	9·371069	11 95	10·628931	9·383405	11 101	10·616595	10·012336	11 6	9·987664	38	30
36	24	9·371330	12 104	10·628670	9·383682	12 110	10·616318	10·012351	12 6	9·987649	36	24
30	26	9·371591	13 113	10·628409	9·383958	13 120	10·616042	10·012366	13 7	9·987634	34	30
37	28	9·371852	14 122	10·628148	9·384234	14 129	10·615766	10·012382	14 7	9·987618	32	23
30	30	9·372113	15 130	10·627887	9·384510	15 138	10·615490	10·012397	15 8	9·987603	30	30
38	32	9·372373	16 139	10·627627	9·384786	16 147	10·615214	10·012412	16 8	9·987588	28	22
30	34	9·372634	17 148	10·627366	9·385062	17 156	10·614938	10·012428	17 9	9·987572	26	30
39	36	9·372894	18 156	10·627106	9·385337	18 166	10·614663	10·012443	18 9	9·987557	24	21
30	38	9·373154	19 165	10·626846	9·385612	19 175	10·614388	10·012458	19 10	9·987542	22	30
40	40	9·373414	20 174	10·626586	9·385888	20 184	10·614112	10·012474	20 10	9·987526	20	20
30	42	9·373674	21 182	10·626326	9·386163	21 193	10·613837	10·012489	21 11	9·987511	18	30
41	44	9·373933	22 191	10·626067	9·386438	22 202	10·613562	10·012504	22 11	9·987496	16	19
30	46	9·374192	23 200	10·625808	9·386712	23 212	10·613288	10·012520	23 12	9·987480	14	30
42	48	9·374452	24 208	10·625548	9·386987	24 221	10·613013	10·012535	24 12	9·987465	12	18
30	50	9·374711	25 217	10·625289	9·387261	25 230	10·612739	10·012551	25 13	9·987449	10	30
43	52	9·374970	26 226	10·625030	9·387536	26 239	10·612464	10·012566	26 13	9·987434	8	17
30	54	9·375228	27 235	10·624772	9·387810	27 248	10·612190	10·012581	27 14	9·987419	6	30
44	56	9·375487	28 243	10·624513	9·388084	28 258	10·611916	10·012597	28 14	9·987403	4	16
30	58	9·375745	29 252	10·624255	9·388358	29 267	10·611642	10·012612	29 15	9·987388	2	30
45	**55**	9·376003	30 261	10·623997	9·388631	30 276	10·611369	10·012628	30 15	9·987372	**5**	15
30	2	9·376261	1 8	10·623739	9·388905	1 9	10·611095	10·012643	1 1	9·987357	58	30
46	4	9·376519	2 17	10·623481	9·389178	2 18	10·610822	10·012659	2 1	9·987341	56	14
30	6	9·376777	3 25	10·623223	9·389451	3 27	10·610549	10·012674	3 2	9·987326	54	30
47	8	9·377035	4 34	10·622965	9·389724	4 36	10·610276	10·012690	4 2	9·987310	52	13
30	10	9·377292	5 42	10·622708	9·389997	5 45	10·610003	10·012705	5 3	9·987295	50	30
48	12	9·377549	6 51	10·622451	9·390270	6 54	10·609730	10·012721	6 3	9·987279	48	12
30	14	9·377806	7 59	10·622194	9·390543	7 63	10·609457	10·012736	7 4	9·987264	46	30
49	16	9·378063	8 68	10·621937	9·390815	8 72	10·609185	10·012752	8 4	9·987248	44	11
30	18	9·378320	9 76	10·621680	9·391087	9 81	10·608913	10·012767	9 5	9·987233	42	30
50	20	9·378577	10 85	10·621423	9·391360	10 90	10·608640	10·012783	10 5	9·987217	40	10
30	22	9·378833	11 94	10·621167	9·391632	11 99	10·608368	10·012798	11 6	9·987202	38	30
51	24	9·379089	12 102	10·620911	9·391903	12 108	10·608097	10·012814	12 6	9·987186	36	9
30	26	9·379346	13 111	10·620654	9·392175	13 118	10·607825	10·012830	13 7	9·987170	34	30
52	28	9·379601	14 119	10·620399	9·392447	14 127	10·607553	10·012845	14 7	9·987155	32	8
30	30	9·379857	15 128	10·620143	9·392718	15 136	10·607282	10·012861	15 8	9·987139	30	30
53	32	9·380113	16 136	10·619887	9·392989	16 145	10·607011	10·012876	16 8	9·987124	28	7
30	34	9·380368	17 145	10·619632	9·393260	17 154	10·606740	10·012892	17 9	9·987108	26	30
54	36	9·380624	18 153	10·619376	9·393531	18 163	10·606469	10·012908	18 9	9·987092	24	6
30	38	9·380879	19 162	10·619121	9·393802	19 172	10·606198	10·012923	19 10	9·987077	22	30
55	40	9·381134	20 170	10·618866	9·394073	20 181	10·605927	10·012939	20 10	9·987061	20	5
30	42	9·381389	21 179	10·618611	9·394343	21 190	10·605657	10·012955	21 11	9·987045	18	30
56	44	9·381643	22 187	10·618357	9·394614	22 199	10·605386	10·012970	22 11	9·987030	16	4
30	46	9·381898	23 196	10·618102	9·394884	23 208	10·605116	10·012986	23 12	9·987014	14	30
57	48	9·382152	24 204	10·617848	9·395154	24 217	10·604846	10·013002	24 12	9·986998	12	3
30	50	9·382406	25 213	10·617594	9·395424	25 226	10·604576	10·013017	25 13	9·986983	10	30
58	52	9·382661	26 222	10·617339	9·395694	26 235	10·604306	10·013033	26 14	9·986967	8	2
30	54	9·382914	27 230	10·617086	9·395963	27 244	10·604037	10·013049	27 14	9·986951	6	30
59	56	9·383168	28 239	10·616832	9·396233	28 253	10·603767	10·013064	28 15	9·986936	4	1
30	58	9·383422	29 247	10·616578	9·396502	29 262	10·603498	10·013080	29 15	9·986920	2	30
60	**56**	9·383675	30 256	10·616325	9·396771	30 271	10·603229	10·013096	30 16	9·986904	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

76° 5ʰ 4ᵐ

LOG. SINES, COSINES, &c.

0h 56m — 14°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·383675		10·616325	9·396771		10·603229	10·013096		9·986904	4	60
30	2	9·383928	1″ 8	10·616072	9·397040	1″ 9	10·602960	10·013112	1″ 1	9·986888	58	30
1	4	9·384182	2 17	10·615818	9·397309	2 18	10·602691	10·013127	2 1	9·986873	56	59
30	6	9·384435	3 25	10·615565	9·397578	3 27	10·602422	10·013143	3 2	9·986857	54	30
2	8	9·384687	4 33	10·615313	9·397846	4 36	10·602154	10·013159	4 2	9·986841	52	58
30	10	9·384940	5 42	10·615060	9·398115	5 44	10·601885	10·013175	5 3	9·986825	50	30
3	12	9·385192	6 50	10·614808	9·398383	6 53	10·601617	10·013191	6 3	9·986809	48	57
30	14	9·385445	7 59	10·614555	9·398651	7 62	10·601349	10·013206	7 4	9·986794	46	30
4	16	9·385697	8 67	10·614303	9·398919	8 71	10·601081	10·013222	8 4	9·986778	44	56
30	18	9·385949	9 75	10·614051	9·399187	9 80	10·600813	10·013238	9 5	9·986762	42	30
5	20	9·386201	10 84	10·613799	9·399455	10 89	10·600545	10·013254	10 5	9·986746	40	55
30	22	9·386452	11 92	10·613548	9·399722	11 98	10·600278	10·013270	11 5	9·986730	38	30
6	24	9·386704	12 100	10·613296	9·399990	12 107	10·600010	10·013286	12 6	9·986714	36	54
30	20	9·386955	13 109	10·613045	9·400257	13 116	10·599743	10·013301	13 7	9·986699	34	30
7	28	9·387207	14 118	10·612793	9·400524	14 125	10·599476	10·013317	14 7	9·986683	32	53
30	30	9·387458	15 126	10·612542	9·400791	15 133	10·599209	10·013333	15 8	9·986667	30	30
8	32	9·387709	16 134	10·612291	9·401058	16 142	10·598942	10·013349	16 8	9·986651	28	52
30	34	9·387959	17 142	10·612041	9·401325	17 151	10·598675	10·013365	17 9	9·986635	26	30
9	30	9·388210	18 150	10·611790	9·401591	18 160	10·598409	10·013381	18 10	9·986619	24	51
30	38	9·388461	19 159	10·611539	9·401857	19 169	10·598143	10·013397	19 10	9·986603	22	30
10	40	9·388711	20 167	10·611289	9·402124	20 178	10·597876	10·013413	20 11	9·986587	20	50
30	42	9·388961	21 176	10·611039	9·402390	21 187	10·597610	10·013429	21 11	9·986571	18	30
11	44	9·389211	22 184	10·610789	9·402656	22 196	10·597344	10·013445	22 12	9·986555	16	49
30	46	9·389461	23 192	10·610539	9·402922	23 205	10·597078	10·013461	23 12	9·986539	14	30
12	48	9·389711	24 201	10·610289	9·403187	24 214	10·596813	10·013477	24 13	9·986523	12	48
30	50	9·389960	25 209	10·610040	9·403453	25 222	10·596547	10·013493	25 13	9·986507	10	30
13	52	9·390210	26 218	10·609790	9·403718	26 231	10·596282	10·013509	26 14	9·986491	8	47
30	54	9·390459	27 227	10·609541	9·403983	27 240	10·596017	10·013525	27 14	9·986475	6	30
14	56	9·390708	28 236	10·609292	9·404249	28 249	10·595751	10·013541	28 15	9·986459	4	46
30	58	9·390957	29 244	10·609043	9·404514	29 258	10·595486	10·013557	29 15	9·986443	2	30
15	**57**	9·391206	30 251	10·608794	9·404778	30 267	10·595222	10·013573	30 16	9·986427	**3**	45
30	2	9·391454	1 8	10·608546	9·405043	1 9	10·594957	10·013589	1 1	9·986411	58	30
16	4	9·391703	2 16	10·608297	9·405308	2 17	10·594692	10·013605	2 1	9·986395	56	44
30	6	9·391951	3 25	10·608049	9·405572	3 26	10·594428	10·013621	3 2	9·986379	54	30
17	8	9·392199	4 33	10·607801	9·405836	4 35	10·594164	10·013637	4 2	9·986363	52	43
30	10	9·392447	5 41	10·607553	9·406100	5 44	10·593900	10·013653	5 3	9·986347	50	30
18	12	9·392695	6 49	10·607305	9·406364	6 52	10·593636	10·013669	6 3	9·986331	48	42
30	14	9·392943	7 57	10·607057	9·406628	7 61	10·593372	10·013685	7 4	9·986315	46	30
19	16	9·393191	8 66	10·606809	9·406892	8 70	10·593108	10·013701	8 4	9·986299	44	41
30	18	9·393438	9 74	10·606562	9·407155	9 79	10·592845	10·013718	9 5	9·986282	42	30
20	20	9·393685	10 82	10·606315	9·407419	10 87	10·592581	10·013734	10 5	9·986266	40	40
30	22	9·393932	11 90	10·606058	9·407682	11 96	10·592318	10·013750	11 6	9·986250	38	30
21	24	9·394179	12 98	10·605821	9·407945	12 105	10·592055	10·013766	12 6	9·986234	36	39
30	26	9·394426	13 106	10·605574	9·408208	13 114	10·591792	10·013782	13 7	9·986218	34	30
22	28	9·394673	14 114	10·605327	9·408471	14 122	10·591529	10·013798	14 8	9·986202	32	38
30	30	9·394919	15 123	10·605081	9·408734	15 131	10·591266	10·013814	15 8	9·986186	30	30
23	32	9·395166	16 132	10·604834	9·408996	16 140	10·591004	10·013831	16 9	9·986169	28	37
30	34	9·395412	17 140	10·604588	9·409259	17 149	10·590741	10·013847	17 9	9·986153	26	30
24	36	9·395658	18 148	10·604342	9·409521	18 157	10·590479	10·013863	18 10	9·986137	24	36
30	38	9·395904	19 156	10·604096	9·409783	19 166	10·590217	10·013879	19 10	9·986121	22	30
25	40	9·396150	20 164	10·603850	9·410045	20 175	10·589955	10·013896	20 11	9·986104	20	35
30	42	9·396395	21 172	10·603605	9·410307	21 184	10·589693	10·013912	21 11	9·986088	18	30
26	44	9·396641	22 180	10·603359	9·410569	22 192	10·589431	10·013928	22 12	9·986072	16	34
30	40	9·396886	23 189	10·603114	9·410831	23 201	10·589169	10·013944	23 12	9·986056	14	30
27	48	9·397132	24 197	10·602868	9·411092	24 210	10·588908	10·013961	24 13	9·986039	12	33
30	50	9·397377	25 205	10·602623	9·411353	25 219	10·588647	10·013977	25 13	9·986023	10	30
28	52	9·397621	26 213	10·602379	9·411615	26 227	10·588385	10·013993	26 14	9·986007	8	32
30	54	9·397866	27 221	10·602134	9·411876	27 236	10·588124	10·014009	27 15	9·985991	6	30
29	56	9·398111	28 229	10·601889	9·412137	28 245	10·587863	10·014026	28 15	9·985974	4	31
30	58	9·398355	29 237	10·601645	9·412397	29 254	10·587603	10·014042	29 16	9·985958	2	30
30	**58**	9·398600	30 246	10·601400	9·412658	30 262	10·587342	10·014058	30 16	9·985942	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

75° — 5h 2m

LOG. SINES, COSINES, &c.

$0^h\ 58^m$ 14°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
30	0	9·398600		10·601400	9·412658		10·587342	10·014058		9·985942	2	30
30	2	9·398844	1″ 8	10·601156	9·412919	1″ 9	10·587081	10·014075	1″ 1	9·985925	58	30
31	4	9·399088	2 16	10·600912	9·413179	2 17	10·586821	10·014091	2 1	9·985909	56	29
30	6	9·399332	3 24	10·600668	9·413439	3 26	10·586561	10·014107	3 2	9·985893	54	30
32	8	9·399575	4 32	10·600425	9·413699	4 34	10·586301	10·014124	4 2	9·985876	52	28
30	10	9·399819	5 40	10·600181	9·413959	5 43	10·586041	10·014140	5 3	9·985860	50	30
33	12	9·400062	6 48	10·599938	9·414219	6 52	10·585781	10·014157	6 3	9·985843	48	27
30	14	9·400306	7 56	10·599694	9·414479	7 60	10·585521	10·014173	7 4	9·985827	46	30
34	16	9·400549	8 65	10·599451	9·414738	8 69	10·585262	10·014189	8 4	9·985811	44	26
30	18	9·400792	9 73	10·599208	9·414998	9 78	10·585002	10·014206	9 5	9·985794	42	30
35	20	9·401035	10 81	10·598965	9·415257	10 86	10·584743	10·014222	10 5	9·985778	40	25
30	22	9·401277	11 89	10·598723	9·415516	11 95	10·584484	10·014239	11 6	9·985761	38	30
36	24	9·401520	12 96	10·598480	9·415775	12 103	10·584225	10·014255	12 7	9·985745	36	24
30	26	9·401762	13 104	10·598238	9·416034	13 112	10·583966	10·014272	13 7	9·985728	34	30
37	28	9·402005	14 112	10·597995	9·416293	14 121	10·583707	10·014288	14 8	9·985712	32	23
30	30	9·402247	15 120	10·597753	9·416551	15 129	10·583449	10·014305	15 8	9·985695	30	30
38	32	9·402489	16 129	10·597511	9·416810	16 138	10·583190	10·014321	16 9	9·985679	28	22
30	34	9·402731	17 137	10·597269	9·417068	17 147	10·582932	10·014338	17 9	9·985662	26	30
39	36	9·402972	18 145	10·597028	9·417326	18 155	10·582674	10·014354	18 10	9·985646	24	21
30	38	9·403214	19 153	10·596786	9·417585	19 164	10·582415	10·014371	19 10	9·985629	22	30
40	40	9·403455	20 161	10·596545	9·417842	20 172	10·582158	10·014387	20 11	9·985613	20	20
30	42	9·403697	21 169	10·596303	9·418100	21 181	10·581900	10·014404	21 12	9·985596	18	30
41	44	9·403938	22 178	10·596062	9·418358	22 190	10·581642	10·014420	22 12	9·985580	16	19
30	46	9·404179	23 186	10·595821	9·418616	23 198	10·581384	10·014437	23 13	9·985563	14	30
42	48	9·404420	24 194	10·595580	9·418873	24 207	10·581127	10·014453	24 13	9·985547	12	18
30	50	9·404660	25 202	10·595340	9·419130	25 215	10·580870	10·014470	25 14	9·985530	10	30
43	52	9·404901	26 210	10·595099	9·419387	26 224	10·580613	10·014486	26 14	9·985514	8	17
30	54	9·405141	27 218	10·594859	9·419644	27 233	10·580356	10·014503	27 15	9·985497	6	30
44	56	9·405382	28 226	10·594618	9·419901	28 241	10·580099	10·014520	28 15	9·985480	4	16
30	58	9·405622	29 234	10·594378	9·420158	29 250	10·579842	10·014536	29 16	9·985464	2	30
45	**59**	9·405862	30 242	10·594138	9·420415	30 259	10·579585	10·014553	30 16	9·985447	**1**	15
30	2	9·406102	1 8	10·593898	9·420671	1 8	10·579329	10·014570	1 1	9·985430	58	30
46	4	9·406341	2 16	10·593659	9·420927	2 17	10·579073	10·014586	2 1	9·985414	56	14
30	6	9·406581	3 24	10·593419	9·421184	3 25	10·578816	10·014603	3 2	9·985397	54	30
47	8	9·406820	4 32	10·593180	9·421440	4 34	10·578560	10·014619	4 2	9·985381	52	13
30	10	9·407060	5 40	10·592940	9·421696	5 42	10·578304	10·014636	5 3	9·985364	50	30
48	12	9·407299	6 48	10·592701	9·421952	6 51	10·578048	10·014653	6 3	9·985347	48	12
30	14	9·407538	7 55	10·592462	9·422207	7 59	10·577793	10·014670	7 4	9·985330	46	30
49	16	9·407777	8 63	10·592223	9·422463	8 68	10·577537	10·014686	8 4	9·985314	44	11
30	18	9·408015	9 71	10·591985	9·422718	9 76	10·577282	10·014703	9 5	9·985297	42	30
50	20	9·408254	10 79	10·591746	9·422974	10 85	10·577026	10·014720	10 6	9·985280	40	10
30	22	9·408492	11 87	10·591508	9·423229	11 93	10·576771	10·014736	11 6	9·985264	38	30
51	24	9·408731	12 95	10·591269	9·423484	12 102	10·576516	10·014753	12 7	9·985247	36	9
30	26	9·408969	13 103	10·591031	9·423739	13 110	10·576261	10·014770	13 7	9·985230	34	30
52	28	9·409207	14 111	10·590793	9·423993	14 119	10·576007	10·014787	14 8	9·985213	32	8
30	30	9·409445	15 118	10·590555	9·424248	15 127	10·575752	10·014803	15 8	9·985197	30	30
53	32	9·409682	16 126	10·590318	9·424503	16 136	10·575497	10·014820	16 9	9·985180	28	7
30	34	9·409920	17 134	10·590080	9·424757	17 144	10·575243	10·014837	17 10	9·985163	26	30
54	36	9·410157	18 142	10·589843	9·425011	18 153	10·574989	10·014854	18 10	9·985146	24	6
30	38	9·410395	19 150	10·589605	9·425265	19 161	10·574735	10·014871	19 11	9·985129	22	30
55	40	9·410632	20 158	10·589368	9·425519	20 170	10·574481	10·014887	20 11	9·985113	20	5
30	42	9·410869	21 166	10·589131	9·425773	21 178	10·574227	10·014904	21 12	9·985096	18	30
56	44	9·411106	22 174	10·588894	9·426027	22 187	10·573973	10·014921	22 12	9·985079	16	4
30	46	9·411343	23 182	10·588657	9·426281	23 195	10·573719	10·014938	23 13	9·985062	14	30
57	48	9·411579	24 190	10·588421	9·426534	24 204	10·573466	10·014955	24 13	9·985045	12	3
30	50	9·411816	25 198	10·588184	9·426787	25 212	10·573212	10·014972	25 14	9·985028	10	30
58	52	9·412052	26 206	10·587948	9·427041	26 220	10·572959	10·014989	26 15	9·985011	8	2
30	54	9·412288	27 214	10·587712	9·427294	27 229	10·572706	10·015005	27 15	9·984995	6	30
59	56	9·412524	28 222	10·587476	9·427547	28 237	10·572453	10·015022	28 16	9·984978	4	1
30	58	9·412760	29 230	10·587240	9·427800	29 246	10·572200	10·015039	29 16	9·984961	2	30
60	**60**	9·412996	30 238	10·587004	9·428052	30 254	10·571948	10·015056	30 17	9·984944	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

75° $5^h\ 0^m$

LOG. SINES, COSINES, &c.

1h 0m — 15°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·412996		10·587004	9·428052		10·571948	10·015056		9·984944	60	60
30	2	9·413232	1″ 8	10·586768	9·428305	1″ 8	10·571695	10·015073	1″ 1	9·984927	58	30
1	4	9·413467	2 16	10·586533	9·428558	2 17	10·571442	10·015090	2 1	9·984910	56	59
30	6	9·413703	3 23	10·586297	9·428810	3 25	10·571190	10·015107	3 2	9·984893	54	30
2	8	9·413938	4 31	10·586062	9·429062	4 33	10·570938	10·015124	4 2	9·984876	52	58
30	10	9·414173	5 39	10·585827	9·429314	5 42	10·570686	10·015141	5 3	9·984859	50	30
3	12	9·414408	6 47	10·585592	9·429566	6 50	10·570434	10·015158	6 3	9·984842	48	57
30	14	9·414643	7 55	10·585357	9·429818	7 59	10·570182	10·015175	7 4	9·984825	46	30
4	16	9·414878	8 62	10·585122	9·430070	8 67	10·569930	10·015192	8 5	9·984808	44	56
30	18	9·415112	9 70	10·584888	9·430321	9 75	10·569679	10·015209	9 5	9·984791	42	30
5	20	9·415347	10 78	10·584653	9·430573	10 84	10·569427	10·015226	10 6	9·984774	40	55
30	22	9·415581	11 86	10·584419	9·430824	11 92	10·569176	10·015243	11 6	9·984757	38	30
6	24	9·415815	12 94	10·584185	9·431075	12 100	10·568925	10·015260	12 7	9·984740	36	54
30	26	9·416049	13 101	10·583951	9·431326	13 109	10·568674	10·015277	13 7	9·984723	34	30
7	28	9·416283	14 109	10·583717	9·431577	14 117	10·568423	10·015294	14 8	9·984706	32	53
30	30	9·416517	15 117	10·583483	9·431828	15 125	10·568172	10·015311	15 9	9·984689	30	30
8	32	9·416751	16 125	10·583249	9·432079	16 134	10·567921	10·015328	16 9	9·984672	28	52
30	34	9·416984	17 133	10·583016	9·432329	17 142	10·567671	10·015345	17 10	9·984655	26	30
9	36	9·417217	18 140	10·582783	9·432580	18 150	10·567420	10·015362	18 10	9·984638	24	51
30	38	9·417451	19 148	10·582549	9·432830	19 159	10·567170	10·015380	19 11	9·984620	22	30
10	40	9·417684	20 156	10·582316	9·433080	20 167	10·566920	10·015397	20 11	9·984603	20	50
30	42	9·417917	21 164	10·582083	9·433331	21 176	10·566669	10·015414	21 12	9·984586	18	30
11	44	9·418150	22 171	10·581850	9·433580	22 184	10·566420	10·015431	22 13	9·984569	16	49
30	46	9·418382	23 179	10·581618	9·433830	23 192	10·566170	10·015448	23 13	9·984552	14	30
12	48	9·418615	24 187	10·581385	9·434080	24 201	10·565920	10·015465	24 14	9·984535	12	48
30	50	9·418847	25 195	10·581153	9·434330	25 209	10·565670	10·015482	25 14	9·984518	10	30
13	52	9·419079	26 203	10·580921	9·434579	26 217	10·565421	10·015500	26 15	9·984500	8	47
30	54	9·419312	27 210	10·580688	9·434828	27 226	10·565172	10·015517	27 15	9·984483	6	30
14	56	9·419544	28 218	10·580456	9·435078	28 234	10·564922	10·015534	28 16	9·984466	4	46
30	58	9·419776	29 226	10·580224	9·435327	29 242	10·564673	10·015551	29 17	9·984449	2	30
15	1	9·420007	30 234	10·579993	9·435576	30 251	10·564424	10·015568	30 17	9·984432	59	45
30	2	9·420239	1 8	10·579761	9·435825	1 8	10·564175	10·015586	1 1	9·984414	58	30
16	4	9·420470	2 15	10·579530	9·436073	2 16	10·563927	10·015603	2 1	9·984397	56	44
30	6	9·420702	3 23	10·579298	9·436322	3 25	10·563678	10·015620	3 2	9·984380	54	30
17	8	9·420933	4 31	10·579067	9·436570	4 33	10·563430	10·015637	4 2	9·984363	52	43
30	10	9·421164	5 38	10·578836	9·436819	5 41	10·563181	10·015655	5 3	9·984345	50	30
18	12	9·421395	6 46	10·578605	9·437067	6 49	10·562933	10·015672	6 3	9·984328	48	42
30	14	9·421626	7 54	10·578374	9·437315	7 58	10·562685	10·015689	7 4	9·984311	46	30
19	16	9·421857	8 61	10·578143	9·437563	8 66	10·562437	10·015706	8 5	9·984294	44	41
30	18	9·422087	9 69	10·577913	9·437811	9 74	10·562189	10·015724	9 5	9·984276	42	30
20	20	9·422318	10 77	10·577682	9·438059	10 82	10·561941	10·015741	10 6	9·984259	40	40
30	22	9·422548	11 85	10·577452	9·438306	11 91	10·561694	10·015758	11 6	9·984242	38	30
21	24	9·422778	12 92	10·577222	9·438554	12 99	10·561446	10·015776	12 7	9·984224	36	39
30	26	9·423008	13 100	10·576992	9·438801	13 107	10·561199	10·015793	13 8	9·984207	34	30
22	28	9·423238	14 108	10·576762	9·439048	14 115	10·560952	10·015810	14 8	9·984190	32	38
30	30	9·423468	15 115	10·576532	9·439296	15 123	10·560704	10·015828	15 9	9·984172	30	30
23	32	9·423697	16 123	10·576303	9·439543	16 132	10·560457	10·015845	16 9	9·984155	28	37
30	34	9·423927	17 131	10·576073	9·439790	17 140	10·560210	10·015863	17 10	9·984137	26	30
24	36	9·424156	18 138	10·575844	9·440036	18 148	10·559964	10·015880	18 10	9·984120	21	36
30	38	9·424386	19 146	10·575614	9·440283	19 156	10·559717	10·015897	19 11	9·984103	22	30
25	40	9·424615	20 153	10·575385	9·440529	20 165	10·559471	10·015915	20 12	9·984085	20	35
30	42	9·424844	21 161	10·575156	9·440776	21 173	10·559224	10·015932	21 12	9·984068	18	30
26	44	9·425073	22 169	10·574927	9·441022	22 181	10·558978	10·015950	22 13	9·984050	16	34
30	46	9·425301	23 176	10·574699	9·441268	23 189	10·558732	10·015967	23 13	9·984033	14	30
27	48	9·425530	24 184	10·574470	9·441514	24 198	10·558486	10·015985	24 14	9·984015	12	33
30	50	9·425758	25 192	10·574242	9·441760	25 206	10·558240	10·016002	25 14	9·983998	10	30
28	52	9·425987	26 199	10·574013	9·442006	26 214	10·557994	10·016019	26 15	9·983981	8	32
30	54	9·426215	27 207	10·573785	9·442252	27 222	10·557748	10·016037	27 16	9·983963	6	30
29	56	9·426443	28 215	10·573557	9·442497	28 230	10·557503	10·016054	28 16	9·983946	4	31
30	58	9·426671	29 222	10·573329	9·442743	29 239	10·557257	10·016072	29 17	9·983928	2	30
30	2	9·426899	30 230	10·573101	9·442988	30 247	10·557012	10·016089	30 17	9·983911	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

74° — 4h 58m

LOG. SINES, COSINES, &c.

1h 2m — 15°

″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	″
30	0	9·426899		10·573101	9·442988		10·557012	10·016089		9·983911	58	30
30	2	9·427127	1″ 8	10·572873	9·443234	1″ 8	10·556765	10·016107	1″ 1	9·983893	58	30
31	4	9·427354	2 15	10·572646	9·443479	2 16	10·556521	10·016125	2 1	9·983875	56	29
30	6	9·427582	3 23	10·572418	9·443724	3 24	10·556276	10·016142	3 2	9·983858	54	30
32	8	9·427809	4 30	10·572191	9·443968	4 32	10·556032	10·016160	4 2	9·983840	52	28
30	10	9·428036	5 38	10·571964	9·444213	5 41	10·555787	10·016177	5 3	9·983823	50	30
33	12	9·428263	6 45	10·571737	9·444458	6 49	10·555542	10·016195	6 4	9·983805	48	27
30	14	9·428490	7 53	10·571510	9·444702	7 57	10·555298	10·016212	7 4	9·983788	46	30
34	16	9·428717	8 60	10·571283	9·444947	8 65	10·555053	10·016230	8 5	9·983770	44	26
30	18	9·428944	9 68	10·571056	9·445191	9 73	10·554809	10·016248	9 5	9·983752	42	30
35	20	9·429170	10 75	10·570830	9·445435	10 81	10·554565	10·016265	10 6	9·983735	40	25
30	22	9·429397	11 83	10·570603	9·445679	11 89	10·554321	10·016283	11 6	9·983717	38	30
36	24	9·429623	12 90	10·570377	9·445923	12 97	10·554077	10·016300	12 7	9·983700	36	24
30	26	9·429849	13 98	10·570151	9·446167	13 106	10·553833	10·016318	13 8	9·983682	34	30
37	28	9·430075	14 105	10·569925	9·446411	14 114	10·553589	10·016336	14 8	9·983664	32	23
30	30	9·430301	15 113	10·569699	9·446654	15 122	10·553346	10·016353	15 9	9·983647	30	30
38	32	9·430527	16 120	10·569473	9·446898	16 130	10·553102	10·016371	16 9	9·983629	28	22
30	34	9·430752	17 128	10·569248	9·447141	17 138	10·552859	10·016389	17 10	9·983611	26	30
39	36	9·430978	18 135	10·569022	9·447384	18 146	10·552616	10·016406	18 11	9·983594	24	21
30	38	9·431203	19 143	10·568797	9·447627	19 154	10·552373	10·016424	19 11	9·983576	22	30
40	40	9·431429	20 151	10·568571	9·447870	20 162	10·552130	10·016442	20 12	9·983558	20	20
30	42	9·431654	21 158	10·568346	9·448113	21 171	10·551887	10·016460	21 12	9·983540	18	30
41	44	9·431879	22 166	10·568121	9·448356	22 179	10·551644	10·016477	22 13	9·983523	16	19
30	46	9·432104	23 173	10·567896	9·448599	23 187	10·551401	10·016495	23 14	9·983505	14	30
42	48	9·432329	24 181	10·567671	9·448841	24 195	10·551159	10·016513	24 14	9·983487	12	18
30	50	9·432553	25 188	10·567447	9·449084	25 203	10·550916	10·016531	25 15	9·983469	10	30
43	52	9·432778	26 196	10·567222	9·449326	26 211	10·550674	10·016548	26 15	9·983452	8	17
30	54	9·433002	27 203	10·566998	9·449568	27 219	10·550432	10·016566	27 16	9·983434	6	30
44	56	9·433226	28 210	10·566774	9·449810	28 227	10·550190	10·016584	28 17	9·983416	4	16
30	58	9·433451	29 217	10·566549	9·450052	29 235	10·549948	10·016602	29 17	9·983398	2	30
45	**3**	9·433675	30 226	10·566325	9·450294	30 244	10·549706	10·016619	30 18	9·983381	**57**	15
30	2	9·433898	1 7	10·566102	9·450536	1 8	10·549464	10·016637	1 1	9·983363	58	30
46	4	9·434122	2 15	10·565878	9·450777	2 16	10·549223	10·016655	2 1	9·983345	56	14
30	6	9·434346	3 22	10·565654	9·451019	3 24	10·548981	10·016673	3 2	9·983327	54	30
47	8	9·434569	4 30	10·565431	9·451260	4 32	10·548740	10·016691	4 2	9·983309	52	13
30	10	9·434793	5 37	10·565207	9·451502	5 40	10·548498	10·016709	5 3	9·983291	50	30
48	12	9·435016	6 44	10·564984	9·451743	6 48	10·548257	10·016727	6 4	9·983273	48	12
30	14	9·435239	7 52	10·564761	9·451984	7 56	10·548016	10·016744	7 4	9·983256	46	30
49	16	9·435462	8 59	10·564538	9·452225	8 64	10·547775	10·016762	8 5	9·983238	44	11
30	18	9·435685	9 67	10·564315	9·452465	9 72	10·547535	10·016780	9 5	9·983220	42	30
50	20	9·435908	10 74	10·564092	9·452706	10 80	10·547294	10·016798	10 6	9·983202	40	10
30	22	9·436131	11 82	10·563869	9·452947	11 88	10·547053	10·016816	11 7	9·983184	38	30
51	24	9·436353	12 89	10·563647	9·453187	12 96	10·546813	10·016834	12 7	9·983166	36	9
30	26	9·436576	13 97	10·563424	9·453428	13 104	10·546572	10·016852	13 8	9·983148	34	30
52	28	9·436798	14 104	10·563202	9·453668	14 112	10·546332	10·016870	14 8	9·983130	32	8
30	30	9·437020	15 111	10·562980	9·453908	15 120	10·546092	10·016888	15 9	9·983112	30	30
53	32	9·437242	16 118	10·562758	9·454148	16 128	10·545852	10·016906	16 10	9·983094	28	7
30	34	9·437464	17 126	10·562536	9·454388	17 136	10·545612	10·016924	17 10	9·983076	26	30
54	36	9·437686	18 133	10·562314	9·454628	18 144	10·545372	10·016942	18 11	9·983058	24	6
30	38	9·437908	19 141	10·562092	9·454867	19 152	10·545133	10·016960	19 11	9·983040	22	30
55	40	9·438129	20 148	10·561871	9·455107	20 160	10·544893	10·016978	20 12	9·983022	20	5
30	42	9·438351	21 156	10·561649	9·455346	21 168	10·544654	10·016996	21 13	9·983004	18	30
56	44	9·438572	22 163	10·561428	9·455586	22 176	10·544414	10·017014	22 13	9·982986	16	4
30	46	9·438793	23 171	10·561207	9·455825	23 184	10·544175	10·017032	23 14	9·982968	14	30
57	48	9·439014	24 178	10·560986	9·456064	24 192	10·543936	10·017050	24 14	9·982950	12	3
30	50	9·439235	25 185	10·560765	9·456303	25 200	10·543697	10·017068	25 15	9·982932	10	30
58	52	9·439456	26 192	10·560544	9·456542	26 208	10·543458	10·017086	26 16	9·982914	8	2
30	54	9·439677	27 200	10·560323	9·456781	27 216	10·543219	10·017104	27 16	9·982896	6	30
59	56	9·439897	28 207	10·560103	9·457019	28 224	10·542981	10·017122	28 17	9·982878	4	1
30	58	9·440118	29 215	10·559882	9·457258	29 232	10·542742	10·017140	29 17	9·982860	2	30
60	**4**	9·440338	30 222	10·559662	9·457496	30 240	10·542504	10·017158	30 18	9·982842	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

74° — 4h 56m

LOG. SINES. COSINES, &c.

1ʰ 4ᵐ 16°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·440338		10·559662	9·457496		10·542504	10·017158		9·982842	56	60
30	2	9·440558	1″ 7	10·559441	9·457735	1″ 8	10·542265	10·017176	1″ 1	9·982824	58	30
1	4	9·440778	2 15	10·559222	9·457973	2 16	10·542027	10·017195	2 1	9·982805	56	59
30	6	9·440998	3 22	10·559002	9·458211	3 24	10·541789	10·017213	3 2	9·982787	54	30
2	8	9·441218	4 29	10·558782	9·458449	4 32	10·541551	10·017231	4 2	9·982769	52	58
30	10	9·441438	5 36	10·558562	9·458687	5 39	10·541313	10·017249	5 3	9·982751	50	30
3	12	9·441658	6 44	10·558342	9·458925	6 47	10·541075	10·017267	6 4	9·982733	48	57
30	11	9·441877	7 51	10·558123	9·459163	7 55	10·540837	10·017285	7 4	9·982715	40	30
4	16	9·442096	8 58	10·557904	9·459400	8 63	10·540600	10·017304	8 5	9·982696	44	56
30	18	9·442316	9 65	10·557684	9·459638	9 71	10·540362	10·017322	9 5	9·982678	42	30
5	20	9·442535	10 73	10·557465	9·459875	10 79	10·540125	10·017340	10 6	9·982660	40	55
30	22	9·442754	11 80	10·557246	9·460112	11 87	10·539888	10·017358	11 7	9·982642	38	30
6	24	9·442973	12 87	10·557027	9·460349	12 95	10·539651	10·017376	12 7	9·982624	36	54
30	26	9·443192	13 95	10·556808	9·460586	13 103	10·539414	10·017395	13 8	9·982605	34	30
7	28	9·443410	14 102	10·556590	9·460823	14 110	10·539177	10·017413	14 9	9·982587	32	53
30	30	9·443629	15 109	10·556371	9·461060	15 118	10·538940	10·017431	15 9	9·982569	30	30
8	32	9·443847	16 116	10·556153	9·461297	16 126	10·538703	10·017449	16 10	9·982551	28	52
30	34	9·444066	17 124	10·555934	9·461533	17 134	10·538467	10·017468	17 10	9·982532	26	30
9	36	9·444284	18 131	10·555716	9·461770	18 142	10·538230	10·017486	18 11	9·982514	24	51
30	38	9·444502	19 138	10·555498	9·462006	19 150	10·537994	10·017504	19 12	9·982496	22	30
10	40	9·444720	20 146	10·555280	9·462242	20 158	10·537758	10·017523	20 12	9·982477	20	50
30	42	9·444938	21 153	10·555062	9·462478	21 166	10·537522	10·017541	21 13	9·982459	18	30
11	44	9·445155	22 160	10·554845	9·462715	22 174	10·537286	10·017559	22 13	9·982441	16	49
30	46	9·445373	23 167	10·554627	9·462950	23 181	10·537050	10·017578	23 14	9·982422	14	30
12	48	9·445590	24 175	10·554410	9·463186	24 189	10·536814	10·017596	24 15	9·982404	12	48
30	50	9·445808	25 182	10·554192	9·463422	25 197	10·536578	10·017614	25 15	9·982386	10	30
13	52	9·446025	26 189	10·553975	9·463658	26 205	10·536342	10·017633	26 16	9·982367	8	47
30	54	9·446242	27 196	10·553758	9·463893	27 213	10·536107	10·017651	27 16	9·982349	6	30
14	56	9·446459	28 204	10·553541	9·464128	28 221	10·535872	10·017669	28 17	9·982331	4	46
30	58	9·446676	29 211	10·553324	9·464364	29 229	10·535636	10·017688	29 18	9·982312	2	30
15	5	9·446893	30 218	10·553107	9·464599	30 237	10·535401	10·017706	30 18	9·982294	55	45
30	2	9·447109	1 7	10·552891	9·464834	1 8	10·535166	10·017725	1 1	9·982275	58	30
16	4	9·447326	2 14	10·552674	9·465069	2 16	10·534931	10·017743	2 1	9·982257	56	44
30	0	9·447542	3 22	10·552458	9·465304	3 23	10·534696	10·017761	3 2	9·982239	54	30
17	8	9·447759	4 29	10·552241	9·465539	4 31	10·534461	10·017780	4 2	9·982220	52	43
30	10	9·447975	5 36	10·552025	9·465773	5 39	10·534227	10·017798	5 3	9·982202	50	30
18	12	9·448191	6 43	10·551809	9·466008	6 47	10·533992	10·017817	6 4	9·982183	48	42
30	14	9·448407	7 50	10·551593	9·466242	7 54	10·533758	10·017835	7 4	9·982165	46	30
19	16	9·448623	8 57	10·551377	9·466477	8 62	10·533523	10·017854	8 5	9·982146	44	41
30	18	9·448838	9 64	10·551162	9·466711	9 70	10·533289	10·017872	9 6	9·982128	42	30
20	20	9·449054	10 72	10·550946	9·466945	10 78	10·533055	10·017891	10 6	9·982109	40	40
30	22	9·449269	11 79	10·550731	9·467179	11 86	10·532821	10·017909	11 7	9·982091	38	30
21	24	9·449485	12 86	10·550515	9·467413	12 93	10·532587	10·017928	12 7	9·982072	36	39
30	26	9·449700	13 93	10·550300	9·467647	13 101	10·532353	10·017946	13 8	9·982054	34	30
22	28	9·449915	14 100	10·550085	9·467880	14 109	10·532120	10·017965	14 9	9·982035	32	38
30	30	9·450130	15 107	10·549870	9·468114	15 117	10·531886	10·017984	15 9	9·982016	30	30
23	32	9·450345	16 114	10·549655	9·468347	16 124	10·531653	10·018002	16 10	9·981998	28	37
30	34	9·450560	17 122	10·549440	9·468581	17 132	10·531419	10·018021	17 11	9·981979	26	30
24	36	9·450775	18 129	10·549225	9·468814	18 140	10·531186	10·018039	18 11	9·981961	24	36
30	38	9·450989	19 136	10·549011	9·469047	19 148	10·530953	10·018058	19 12	9·981942	22	30
25	40	9·451204	20 143	10·548796	9·469280	20 156	10·530720	10·018076	20 12	9·981924	20	35
30	42	9·451418	21 150	10·548582	9·469513	21 163	10·530487	10·018095	21 13	9·981905	18	30
26	44	9·451632	22 157	10·548368	9·469746	22 171	10·530254	10·018114	22 14	9·981886	16	34
30	46	9·451846	23 165	10·548154	9·469979	23 179	10·530021	10·018132	23 14	9·981868	14	30
27	48	9·452060	24 172	10·547940	9·470211	24 187	10·529789	10·018151	24 15	9·981849	12	33
30	50	9·452274	25 179	10·547726	9·470444	25 194	10·529556	10·018170	25 16	9·981830	10	30
28	52	9·452488	26 186	10·547512	9·470676	26 202	10·529324	10·018188	26 16	9·981812	8	32
30	54	9·452702	27 193	10·547298	9·470909	27 210	10·529091	10·018207	27 17	9·981793	6	30
29	56	9·452915	28 200	10·547085	9·471141	28 218	10·528859	10·018226	28 17	9·981774	4	31
30	58	9·453129	29 208	10·546871	9·471373	29 226	10·528627	10·018244	29 18	9·981756	2	30
30	6	9·453342	30 215	10·546658	9·471605	30 233	10·528395	10·018263	30 19	9·981737	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

73° 4ʰ 54ᵐ

LOG. SINES, COSINES, &c.

1ʰ 6ᵐ — 16°

′ ″	m. s.	Sine	Parts	Cosec	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
30	0	9·453342		10·546658	9·471605		10·528395	10·018263		9·981737	54	30
30	2	9·453555	1″ 7	10·546445	9·471837	1″ 8	10·528163	10·018282	1″ 1	9·981718	58	30
31	4	9·453768	2 14	10·546232	9·472069	2 15	10·527931	10·018300	2 1	9·981700	56	29
30	6	9·453981	3 21	10·546019	9·472300	3 23	10·527700	10·018319	3 2	9·981681	54	30
32	8	9·454194	4 28	10·545806	9·472532	4 31	10·527468	10·018338	4 3	9·981662	52	28
30	10	9·454407	5 35	10·545593	9·472763	5 38	10·527237	10·018357	5 3	9·981643	50	30
33	12	9·454619	6 42	10·545381	9·472995	6 46	10·527005	10·018375	6 4	9·981625	48	27
30	14	9·454832	7 49	10·545168	9·473226	7 54	10·526774	10·018394	7 4	9·981606	46	30
34	16	9·455044	8 56	10·544956	9·473457	8 61	10·526543	10·018413	8 5	9·981587	44	26
30	18	9·455256	9 63	10·544744	9·473688	9 69	10·526312	10·018432	9 6	9·981568	42	30
35	20	9·455469	10 70	10·544531	9·473919	10 77	10·526081	10·018451	10 6	9·981549	40	25
30	22	9·455681	11 78	10·544319	9·474150	11 84	10·525850	10·018469	11 7	9·981531	38	30
36	24	9·455893	12 85	10·544107	9·474381	12 92	10·525619	10·018488	12 8	9·981512	36	24
30	26	9·456104	13 92	10·543896	9·474612	13 100	10·525388	10·018507	13 8	9·981493	34	30
37	28	9·456316	14 99	10·543684	9·474842	14 108	10·525158	10·018526	14 9	9·981474	32	23
30	30	9·456528	15 106	10·543472	9·475073	15 115	10·524927	10·018545	15 9	9·981455	30	30
38	32	9·456739	16 113	10·543261	9·475303	16 123	10·524697	10·018564	16 10	9·981436	28	22
30	34	9·456951	17 120	10·543049	9·475533	17 131	10·524467	10·018583	17 11	9·981417	26	30
39	36	9·457162	18 127	10·542838	9·475763	18 138	10·524237	10·018601	18 11	9·981399	24	21
30	38	9·457373	19 134	10·542627	9·475993	19 146	10·524007	10·018620	19 12	9·981380	22	30
40	40	9·457584	20 141	10·542416	9·476223	20 154	10·523777	10·018639	20 13	9·981361	20	20
30	42	9·457795	21 148	10·542205	9·476453	21 161	10·523547	10·018658	21 13	9·981342	18	30
41	44	9·458006	22 155	10·541994	9·476683	22 169	10·523317	10·018677	22 14	9·981323	16	19
30	46	9·458217	23 162	10·541783	9·476913	23 177	10·523087	10·018696	23 14	9·981304	14	30
42	48	9·458427	24 169	10·541573	9·477142	24 184	10·522858	10·018715	24 15	9·981285	12	18
30	50	9·458638	25 176	10·541362	9·477372	25 192	10·522628	10·018734	25 16	9·981266	10	30
43	52	9·458848	26 183	10·541152	9·477601	26 200	10·522399	10·018753	26 16	9·981247	8	17
30	54	9·459058	27 190	10·540942	9·477830	27 207	10·522170	10·018772	27 17	9·981228	6	30
44	56	9·459268	28 197	10·540732	9·478059	28 215	10·521941	10·018791	28 18	9·981209	4	16
30	58	9·459478	29 204	10·540522	9·478288	29 223	10·521712	10·018810	29 18	9·981190	2	30
45	7	9·459688	30 211	10·540312	9·478517	30 230	10·521483	10·018829	30 19	9·981171	53	15
30	2	9·459898	1 7	10·540102	9·478746	1 8	10·521254	10·018848	1 1	9·981152	58	30
46	4	9·460108	2 14	10·539892	9·478975	2 15	10·521025	10·018867	2 1	9·981133	56	14
30	6	9·460317	3 21	10·539683	9·479203	3 23	10·520797	10·018886	3 2	9·981114	54	30
47	8	9·460527	4 28	10·539473	9·479432	4 30	10·520568	10·018905	4 3	9·981095	52	13
30	10	9·460736	5 35	10·539264	9·479660	5 38	10·520340	10·018924	5 3	9·981076	50	30
48	12	9·460946	6 42	10·539054	9·479889	6 45	10·520111	10·018943	6 4	9·981057	48	12
30	14	9·461155	7 49	10·538845	9·480117	7 53	10·519883	10·018962	7 4	9·981038	46	30
49	16	9·461364	8 56	10·538636	9·480345	8 61	10·519655	10·018981	8 5	9·981019	44	11
30	18	9·461573	9 62	10·538427	9·480573	9 68	10·519427	10·019000	9 6	9·981000	42	30
50	20	9·461782	10 69	10·538218	9·480801	10 76	10·519199	10·019019	10 6	9·980981	40	10
30	22	9·461990	11 76	10·538010	9·481029	11 83	10·518971	10·019039	11 7	9·980961	38	30
51	24	9·462199	12 83	10·537801	9·481257	12 91	10·518743	10·019058	12 8	9·980942	36	9
30	26	9·462407	13 90	10·537593	9·481484	13 99	10·518516	10·019077	13 8	9·980923	34	30
52	28	9·462616	14 97	10·537384	9·481712	14 106	10·518288	10·019096	14 9	9·980904	32	8
30	30	9·462824	15 104	10·537176	9·481939	15 114	10·518061	10·019115	15 10	9·980885	30	30
53	32	9·463032	16 111	10·536968	9·482167	16 121	10·517833	10·019134	16 10	9·980866	28	7
30	34	9·463240	17 118	10·536760	9·482394	17 129	10·517606	10·019153	17 11	9·980847	26	30
54	36	9·463448	18 125	10·536552	9·482621	18 136	10·517379	10·019173	18 12	9·980827	24	6
30	38	9·463656	19 132	10·536344	9·482848	19 144	10·517152	10·019192	19 12	9·980808	22	30
55	40	9·463864	20 139	10·536136	9·483075	20 152	10·516925	10·019211	20 13	9·980789	20	5
30	42	9·464072	21 146	10·535928	9·483302	21 159	10·516698	10·019230	21 13	9·980770	18	30
56	44	9·464279	22 153	10·535721	9·483529	22 167	10·516471	10·019250	22 14	9·980750	16	4
30	46	9·464486	23 160	10·535514	9·483755	23 174	10·516245	10·019269	23 15	9·980731	14	30
57	48	9·464694	24 167	10·535306	9·483982	24 182	10·516018	10·019288	24 15	9·980712	12	3
30	50	9·464901	25 174	10·535099	9·484208	25 189	10·515792	10·019307	25 16	9·980693	10	30
58	52	9·465108	26 180	10·534892	9·484435	26 197	10·515565	10·019327	26 17	9·980673	8	2
30	54	9·465315	27 187	10·534685	9·484661	27 205	10·515339	10·019346	27 17	9·980654	6	30
59	56	9·465522	28 194	10·534478	9·484887	28 212	10·515113	10·019365	28 18	9·980635	4	1
30	58	9·465729	29 201	10·534271	9·485113	29 220	10·514887	10·019384	29 19	9·980616	2	30
60	8	9·465935	30 208	10·534065	9·485339	30 227	10·514661	10·019404	30 19	9·980596	0	0
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

73° — 4ʰ 52ᵐ

LOG. SINES, COSINES, &c.

1h 8m — 17°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
0	0	9·465935		10·534065	9·485339		10·514661	10·019404		9·980596	52	60
30	2	9·466142	1″ 7	10·533858	9·485565	1″ 7	10·514435	10·019423	1″ 1	9·980577	58	30
1	4	9·466348	2 14	10·533652	9·485791	2 15	10·514209	10·019442	2 1	9·980558	56	59
30	6	9·466555	3 20	10·533445	9·486016	3 22	10·513984	10·019462	3 2	9·980538	54	30
2	8	9·466761	4 27	10·533239	9·486242	4 30	10·513758	10·019481	4 3	9·980519	52	58
30	10	9·466967	5 34	10·533033	9·486467	5 37	10·513533	10·019500	5 3	9·980500	50	30
3	12	9·467173	6 41	10·532827	9·486693	6 45	10·513307	10·019520	6 4	9·980480	48	57
30	14	9·467379	7 48	10·532621	9·486918	7 52	10·513082	10·019539	7 5	9·980461	46	30
4	16	9·467585	8 55	10·532415	9·487143	8 60	10·512857	10·019558	8 5	9·980442	44	56
30	18	9·467790	9 61	10·532210	9·487368	9 67	10·512632	10·019578	9 6	9·980422	42	30
6	20	9·467996	10 68	10·532004	9·487593	10 75	10·512407	10·019597	10 6	9·980403	40	55
30	22	9·468202	11 75	10·531798	9·487818	11 82	10·512182	10·019617	11 7	9·980383	38	30
6	24	9·468407	12 82	10·531593	9·488043	12 90	10·511957	10·019636	12 8	9·980364	36	54
30	26	9·468612	13 89	10·531388	9·488268	13 97	10·511732	10·019656	13 8	9·980344	34	30
7	28	9·468817	14 96	10·531183	9·488492	14 105	10·511508	10·019675	14 9	9·980325	32	53
30	30	9·469022	15 102	10·530978	9·488717	15 112	10·511283	10·019694	15 10	9·980306	30	30
8	32	9·469227	16 109	10·530773	9·488941	16 120	10·511059	10·019714	16 10	9·980286	28	52
30	34	9·469432	17 116	10·530568	9·489166	17 127	10·510834	10·019733	17 11	9·980267	26	30
9	36	9·469637	18 123	10·530363	9·489390	18 135	10·510610	10·019753	18 12	9·980247	24	51
30	38	9·469842	19 130	10·530158	9·489614	19 142	10·510386	10·019772	19 12	9·980228	22	30
10	40	9·470046	20 137	10·529954	9·489838	20 150	10·510162	10·019792	20 13	9·980208	20	50
30	42	9·470251	21 143	10·529749	9·490062	21 157	10·509938	10·019811	21 14	9·980189	18	30
11	44	9·470455	22 150	10·529545	9·490286	22 165	10·509714	10·019831	22 14	9·980169	16	49
30	46	9·470659	23 157	10·529341	9·490510	23 172	10·509490	10·019851	23 15	9·980149	14	30
12	48	9·470863	24 164	10·529137	9·490733	24 180	10·509267	10·019870	24 16	9·980130	12	48
30	50	9·471067	25 171	10·528933	9·490957	25 187	10·509043	10·019890	25 16	9·980110	10	30
13	52	9·471271	26 178	10·528729	9·491180	26 194	10·508820	10·019909	26 17	9·980091	8	47
30	54	9·471475	27 184	10·528525	9·491404	27 202	10·508596	10·019929	27 18	9·980071	6	30
14	56	9·471679	28 191	10·528321	9·491627	28 209	10·508373	10·019948	28 18	9·980052	4	46
30	58	9·471882	29 198	10·528118	9·491850	29 217	10·508150	10·019968	29 19	9·980032	2	30
15	9	9·472086	30 205	10·527914	9·492073	30 224	10·507927	10·019988	30 19	9·980012	51	45
30	2	9·472289	1 7	10·527711	9·492296	1 7	10·507704	10·020007	1 1	9·979993	58	30
16	4	9·472492	2 13	10·527508	9·492519	2 15	10·507481	10·020027	2 1	9·979973	56	44
30	6	9·472695	3 20	10·527305	9·492742	3 22	10·507258	10·020046	3 2	9·979954	54	30
17	8	9·472898	4 27	10·527102	9·492965	4 30	10·507035	10·020066	4 3	9·979934	52	43
30	10	9·473101	5 34	10·526899	9·493187	5 37	10·506813	10·020086	5 3	9·979914	50	30
18	12	9·473304	6 40	10·526696	9·493410	6 44	10·506590	10·020105	6 4	9·979895	48	42
30	14	9·473507	7 47	10·526493	9·493632	7 52	10·506368	10·020125	7 5	9·979875	46	30
19	16	9·473710	8 54	10·526290	9·493854	8 59	10·506146	10·020145	8 5	9·979855	44	41
30	18	9·473912	9 61	10·526088	9·494077	9 66	10·505923	10·020164	9 6	9·979836	42	30
20	20	9·474115	10 67	10·525885	9·494299	10 74	10·505701	10·020184	10 7	9·979816	40	40
30	22	9·474317	11 74	10·525683	9·494521	11 81	10·505479	10·020204	11 7	9·979796	38	30
21	24	9·474519	12 81	10·525481	9·494743	12 89	10·505257	10·020224	12 8	9·979776	36	39
30	26	9·474721	13 88	10·525279	9·494965	13 96	10·505035	10·020243	13 9	9·979757	34	30
22	28	9·474923	14 94	10·525077	9·495186	14 103	10·504814	10·020263	14 9	9·979737	32	38
30	30	9·475125	15 101	10·524875	9·495408	15 111	10·504592	10·020283	15 10	9·979717	30	30
23	32	9·475327	16 108	10·524673	9·495630	16 118	10·504370	10·020303	16 11	9·979697	28	37
30	34	9·475529	17 115	10·524471	9·495851	17 126	10·504149	10·020322	17 11	9·979678	26	30
24	36	9·475730	18 122	10·524270	9·496073	18 133	10·503927	10·020342	18 12	9·979658	24	36
30	38	9·475932	19 128	10·524068	9·496294	19 140	10·503706	10·020362	19 13	9·979638	22	30
25	40	9·476133	20 135	10·523867	9·496515	20 148	10·503485	10·020382	20 13	9·979618	20	35
30	42	9·476335	21 142	10·523665	9·496736	21 155	10·503264	10·020402	21 14	9·979598	18	30
26	44	9·476536	22 149	10·523464	9·496957	22 163	10·503043	10·020421	22 15	9·979579	16	34
30	46	9·476737	23 155	10·523263	9·497178	23 170	10·502822	10·020441	23 15	9·979559	14	30
27	48	9·476938	24 161	10·523062	9·497399	24 177	10·502601	10·020461	24 16	9·979539	12	33
30	50	9·477139	25 168	10·522861	9·497620	25 185	10·502380	10·020481	25 16	9·979519	10	30
28	52	9·477340	26 175	10·522660	9·497841	26 192	10·502159	10·020501	26 17	9·979499	8	32
30	54	9·477540	27 181	10·522460	9·498061	27 200	10·501939	10·020521	27 18	9·979479	6	30
29	56	9·477741	28 188	10·522259	9·498282	28 207	10·501718	10·020541	28 18	9·979459	4	31
30	58	9·477941	29 195	10·522059	9·498502	29 214	10·501498	10·020561	29 19	9·979439	2	30
30	10	9·478142	30 202	10·521858	9·498722	30 222	10·501278	10·020580	30 20	9·979420	0	30
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

72° — 4h 50m

LOG. SINES, COSINES, &c.

1h 10m — 17°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
30	0	9·478142		10·521858	9·498722		10·501278	10·020580		9·979420	50	30
30	2	9·478342	1″ 7	10·521658	9·498943	1″ 7	10·501057	10·020600	1″ 1	9·979400	58	30
31	4	9·478542	2 13	10·521458	9·499163	2 15	10·500837	10·020620	2 1	9·979380	56	29
30	6	9·478742	3 20	10·521258	9·499383	3 22	10·500617	10·020640	3 2	9·979360	54	30
32	8	9·478942	4 26	10·521058	9·499603	4 29	10·500397	10·020660	4 3	9·979340	52	28
30	10	9·479142	5 33	10·520858	9·499822	5 36	10·500178	10·020680	5 3	9·979320	50	30
33	12	9·479342	6 40	10·520658	9·500042	6 44	10·499958	10·020700	6 4	9·979300	48	27
30	14	9·479542	7 46	10·520458	9·500262	7 51	10·499738	10·020720	7 5	9·979280	46	30
34	16	9·479741	8 53	10·520259	9·500481	8 58	10·499519	10·020740	8 5	9·979260	44	26
30	18	9·479941	9 60	10·520059	9·500701	9 66	10·499299	10·020760	9 6	9·979240	42	30
35	20	9·480140	10 66	10·519860	9·500920	10 73	10·499080	10·020780	10 7	9·979220	40	25
30	22	9·480339	11 73	10·519661	9·501140	11 80	10·498860	10·020800	11 7	9·979200	38	30
36	24	9·480539	12 80	10·519461	9·501359	12 88	10·498641	10·020820	12 8	9·979180	36	24
30	26	9·480738	13 86	10·519262	9·501578	13 95	10·498422	10·020840	13 9	9·979160	34	30
37	28	9·480937	14 93	10·519063	9·501797	14 102	10·498203	10·020860	14 9	9·979140	32	23
30	30	9·481135	15 99	10·518865	9·502016	15 109	10·497984	10·020880	15 10	9·979120	30	30
38	32	9·481334	16 106	10·518666	9·502235	16 117	10·497765	10·020900	16 11	9·979100	28	22
30	34	9·481533	17 113	10·518467	9·502453	17 124	10·497547	10·020921	17 11	9·979079	26	30
39	36	9·481731	18 119	10·518269	9·502672	18 131	10·497328	10·020941	18 12	9·979059	24	21
30	38	9·481930	19 126	10·518070	9·502891	19 139	10·497109	10·020961	19 13	9·979039	22	30
40	40	9·482128	20 132	10·517872	9·503109	20 146	10·496891	10·020981	20 13	9·979019	20	20
30	42	9·482327	21 139	10·517673	9·503328	21 153	10·496672	10·021001	21 14	9·978999	18	30
41	44	9·482525	22 146	10·517475	9·503546	22 161	10·496454	10·021021	22 15	9·978979	16	19
30	46	9·482723	23 152	10·517277	9·503764	23 168	10·496236	10·021041	23 15	9·978959	14	30
42	48	9·482921	24 159	10·517079	9·503982	24 175	10·496018	10·021061	24 16	9·978939	12	18
30	50	9·483119	25 166	10·516881	9·504200	25 182	10·495800	10·021082	25 17	9·978918	10	30
43	52	9·483316	26 172	10·516684	9·504418	26 190	10·495582	10·021102	26 17	9·978898	8	17
30	54	9·483514	27 179	10·516486	9·504636	27 197	10·495364	10·021122	27 18	9·978878	6	30
44	56	9·483712	28 186	10·516288	9·504854	28 204	10·495146	10·021142	28 19	9·978858	4	16
30	58	9·483909	29 192	10·516091	9·505072	29 212	10·494928	10·021162	29 19	9·978838	2	30
45	**11**	9·484107	30 199	10·515893	9·505289	30 219	10·494711	10·021183	30 20	9·978817	**49**	15
30	2	9·484304	1 7	10·515696	9·505507	1 7	10·494493	10·021203	1 1	9·978797	58	30
46	4	9·484501	2 13	10·515499	9·505724	2 14	10·494276	10·021223	2 1	9·978777	56	14
30	6	9·484698	3 20	10·515302	9·505941	3 22	10·494059	10·021243	3 2	9·978757	54	30
47	8	9·484895	4 26	10·515105	9·506159	4 29	10·493841	10·021263	4 3	9·978737	52	13
30	10	9·485092	5 33	10·514908	9·506376	5 36	10·493624	10·021284	5 3	9·978716	50	30
48	12	9·485289	6 39	10·514711	9·506593	6 43	10·493407	10·021304	6 4	9·978696	48	12
30	14	9·485485	7 46	10·514515	9·506810	7 50	10·493190	10·021324	7 5	9·978676	46	30
49	16	9·485682	8 52	10·514318	9·507027	8 58	10·492973	10·021345	8 5	9·978655	44	11
30	18	9·485879	9 59	10·514121	9·507243	9 65	10·492757	10·021365	9 6	9·978635	42	30
50	20	9·486075	10 65	10·513925	9·507460	10 72	10·492540	10·021385	10 7	9·978615	40	10
30	22	9·486271	11 72	10·513729	9·507677	11 79	10·492323	10·021406	11 7	9·978594	38	30
51	24	9·486467	12 78	10·513533	9·507893	12 87	10·492107	10·021426	12 8	9·978574	36	9
30	26	9·486664	13 85	10·513336	9·508110	13 94	10·491890	10·021446	13 9	9·978554	34	30
52	28	9·486860	14 91	10·513140	9·508326	14 101	10·491674	10·021467	14 10	9·978533	32	8
30	30	9·487055	15 98	10·512945	9·508542	15 108	10·491458	10·021487	16 10	9·978513	30	30
53	32	9·487251	16 104	10·512749	9·508759	16 115	10·491241	10·021507	16 11	9·978493	28	7
30	34	9·487447	17 111	10·512553	9·508975	17 123	10·491025	10·021528	17 12	9·978472	26	30
54	36	9·487643	18 117	10·512357	9·509191	18 130	10·490809	10·021548	18 12	9·978452	24	6
30	38	9·487838	19 124	10·512162	9·509407	19 137	10·490593	10·021569	19 13	9·978431	22	30
55	40	9·488034	20 131	10·511966	9·509622	20 144	10·490378	10·021589	20 14	9·978411	20	5
30	42	9·488229	21 137	10·511771	9·509838	21 151	10·490162	10·021609	21 14	9·978391	18	30
56	44	9·488424	22 144	10·511576	9·510054	22 159	10·489946	10·021630	22 15	9·978370	16	4
30	46	9·488619	23 150	10·511381	9·510269	23 166	10·489731	10·021650	23 16	9·978350	14	30
57	48	9·488814	24 157	10·511186	9·510485	24 173	10·489515	10·021671	24 16	9·978329	12	3
30	50	9·489009	25 163	10·510991	9·510700	25 180	10·489300	10·021691	25 17	9·978309	10	30
58	52	9·489204	26 170	10·510796	9·510916	26 187	10·489084	10·021712	26 18	9·978288	8	2
30	54	9·489399	27 176	10·510601	9·511131	27 195	10·488869	10·021732	27 18	9·978268	6	30
59	56	9·489593	28 183	10·510407	9·511346	28 202	10·488654	10·021753	28 19	9·978247	4	1
30	58	9·489788	29 189	10·510212	9·511561	29 209	10·488439	10·021773	29 20	9·978227	2	30
60	**12**	9·489982	30 196	10·510018	9·511776	30 216	10·488224	10·021794	30 20	9·978206	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

72° — 4h 48m

LOG. SINES, COSINES, &c.

1ʰ 12ᵐ — 18°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·489982		10·510018	9·511776		10·488224	10·021794		9·978206	48	60
30	2	9·490177	1″ 6	10·509823	9·511991	1″ 7	10·488009	10·021814	1″ 1	9·978186	58	30
1	4	9·490371	2 13	10·509629	9·512206	2 14	10·487794	10·021835	2 1	9·978165	56	59
30	6	9·490565	3 19	10·509435	9·512420	3 21	10·487580	10·021855	3 2	9·978145	54	30
2	8	9·490759	4 26	10·509241	9·512635	4 28	10·487365	10·021876	4 3	9·978124	52	58
30	10	9·490953	5 32	10·509047	9·512850	5 36	10·487150	10·021896	5 3	9·978104	50	30
3	12	9·491147	6 39	10·508853	9·513064	6 43	10·486936	10·021917	6 4	9·978083	48	57
30	14	9·491341	7 45	10·508659	9·513278	7 50	10·486722	10·021938	7 5	9·978062	46	30
4	16	9·491535	8 51	10·508465	9·513493	8 57	10·486507	10·021958	8 6	9·978042	44	56
30	18	9·491728	9 58	10·508272	9·513707	9 64	10·486293	10·021979	9 6	9·978021	42	30
5	20	9·491922	10 64	10·508078	9·513921	10 71	10·486079	10·021999	10 7	9·978001	40	55
30	22	9·492115	11 71	10·507885	9·514135	11 78	10·485865	10·022020	11 8	9·977980	38	30
6	24	9·492308	12 77	10·507692	9·514349	12 85	10·485651	10·022041	12 8	9·977959	36	54
30	26	9·492502	13 84	10·507498	9·514563	13 93	10·485437	10·022061	13 9	9·977939	34	30
7	28	9·492695	14 90	10·507305	9·514777	14 100	10·485223	10·022082	14 10	9·977918	32	53
30	30	9·492888	15 96	10·507112	9·514990	15 107	10·485010	10·022103	15 10	9·977897	30	30
8	32	9·493081	16 103	10·506919	9·515204	16 114	10·484796	10·022123	16 11	9·977877	28	52
30	34	9·493273	17 109	10·506727	9·515417	17 121	10·484583	10·022144	17 12	9·977856	26	30
9	36	9·493466	18 116	10·506534	9·515631	18 128	10·484369	10·022165	18 12	9·977835	24	51
30	38	9·493659	19 122	10·506341	9·515844	19 135	10·484156	10·022185	19 13	9·977815	22	30
10	40	9·493851	20 129	10·506149	9·516057	20 142	10·483943	10·022206	20 14	9·977794	20	50
30	42	9·494044	21 135	10·505956	9·516271	21 150	10·483729	10·022227	21 14	9·977773	18	30
11	44	9·494236	22 142	10·505764	9·516484	22 157	10·483516	10·022248	22 15	9·977752	16	49
30	46	9·494428	23 148	10·505572	9·516697	23 164	10·483303	10·022268	23 16	9·977732	14	30
12	48	9·494621	24 155	10·505379	9·516910	24 171	10·483090	10·022289	24 17	9·977711	12	48
30	50	9·494813	25 161	10·505187	9·517123	25 178	10·482877	10·022310	25 17	9·977690	10	30
13	52	9·495005	26 168	10·504995	9·517335	26 185	10·482665	10·022331	26 18	9·977669	8	47
30	54	9·495196	27 174	10·504804	9·517548	27 192	10·482452	10·022352	27 19	9·977648	0	30
14	56	9·495388	28 180	10·504612	9·517761	28 199	10·482239	10·022372	28 19	9·977628	4	46
30	58	9·495580	29 186	10·504420	9·517973	29 206	10·482027	10·022393	29 20	9·977607	2	30
15	**13**	9·495772	30 193	10·504228	9·518186	30 214	10·481814	10·022414	30 21	9·977586	**47**	45
30	2	9·495963	1 6	10·504037	9·518398	1 7	10·481602	10·022435	1 1	9·977565	58	30
16	4	9·496154	2 13	10·503846	9·518610	2 14	10·481390	10 022456	2 1	9·977544	56	44
30	6	9·496346	3 19	10·503654	9·518822	3 21	10·481178	10·022476	3 2	9·977524	54	30
17	8	9·496537	4 25	10·503463	9·519034	4 28	10·480966	10·022497	4 3	9·977503	52	43
30	10	9·496728	5 32	10·503272	9·519246	5 35	10·480754	10·022518	5 3	9·977482	50	30
18	12	9·496919	6 38	10·503081	9·519458	6 42	10·480542	10·022539	6 4	9·977461	48	42
30	14	9·497110	7 44	10·502890	9·519670	7 49	10·480330	10·022560	7 5	9·977440	40	30
19	16	9·497301	8 51	10·502699	9·519882	8 56	10·480118	10·022581	8 6	9·977419	44	41
30	18	9·497492	9 57	10·502508	9·520094	9 63	10·479906	10·022602	9 6	9·977398	42	30
20	20	9·497682	10 63	10·502318	9·520305	10 70	10·479695	10·022623	10 7	9·977377	40	40
30	22	9·497873	11 70	10·502127	9·520517	11 77	10·479483	10·022644	11 8	9·977356	38	30
21	24	9·498064	12 76	10·501936	9·520728	12 84	10·479272	10·022665	12 8	9·977335	36	39
30	26	9·498254	13 82	10·501746	9·520939	13 91	10·479061	10·022686	13 9	9·977314	34	30
22	28	9·498444	14 89	10·501556	9·521151	14 98	10·478849	10·022707	14 10	9·977293	32	38
30	30	9·498634	15 95	10·501366	9·521362	15 105	10·478638	10·022728	15 10	9·977272	30	30
23	32	9·498825	16 101	10·501175	9·521573	16 112	10·478427	10·022749	16 11	9·977251	28	37
30	34	9·499015	17 108	10·500985	9·521784	17 120	10·478216	10·022770	17 12	9·977230	26	30
24	36	9·499204	18 114	10·500796	9·521995	18 127	10·478005	10·022791	18 13	9·977209	24	36
30	38	9·499394	19 121	10·500606	9·522206	19 134	10·477794	10·022812	19 13	9·977188	22	30
25	40	9·499584	20 127	10·500416	9·522417	20 141	10·477583	10·022833	20 14	9·977167	20	35
30	42	9·499774	21 133	10·500226	9·522627	21 148	10·477373	10·022854	21 15	9·977146	18	30
26	44	9·499963	22 140	10·500037	9·522838	22 155	10·477162	10·022875	22 15	9·977125	16	34
30	46	9·500153	23 146	10·499847	9·523048	23 162	10·476952	10·022896	23 16	9·977104	14	30
27	48	9·500342	24 152	10·499658	9·523259	24 169	10·476741	10·022917	24 17	9·977083	12	33
30	50	9·500531	25 159	10·499469	9·523469	25 176	10·476531	10·022938	25 17	9·977062	10	30
28	52	9·500721	26 165	10·499279	9·523680	26 183	10·476320	10·022959	26 18	9·977041	8	32
30	54	9·500910	27 171	10·499090	9·523890	27 190	10·476110	10·022980	27 19	9·977020	6	30
29	56	9·501099	28 178	10·498901	9·524100	28 197	10·475900	10·023001	28 20	9·976999	4	31
30	58	9·501288	29 184	10·498712	9·524310	29 204	10·475690	10·023022	29 20	9·976978	2	30
30	**14**	9·501476	30 190	10·498524	9·524520	30 211	10·475480	10·023043	30 21	9·976957	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

71° — 4ʰ 46ᵐ

LOG. SINES, COSINES, &c.

1ʰ 14ᵐ — 18°

″ ‴	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	″ ‴
30	0	9·501476		10·498524	9·524520		10·475480	10·023043		9·976957	46	30
30	2	9·501665	1″ 6	10·498335	9·524730	1″ 7	10·475270	10·023065	1″ 1	9·976935	58	30
31	4	9·501854	2 12	10·498146	9·524940	2 14	10·475060	10·023086	2 1	9·976914	56	29
30	6	9·502042	3 19	10·497958	9·525149	3 21	10·474851	10·023107	3 2	9·976893	54	30
32	8	9·502231	4 25	10·497769	9·525359	4 28	10·474641	10·023128	4 3	9·976872	52	28
30	10	9·502419	5 31	10·497581	9·525568	5 35	10·474432	10·023149	5 4	9·976851	50	30
33	12	9·502607	6 37	10·497393	9·525778	6 42	10·474222	10·023170	6 4	9·976830	48	27
30	14	9·502796	7 44	10·497204	9·525987	7 49	10·474013	10·023192	7 5	9·976808	46	30
34	16	9·502984	8 50	10·497016	9·526197	8 56	10·473803	10·023213	8 6	9·976787	44	26
30	18	9·503172	9 56	10·496828	9·526406	9 63	10·473594	10·023234	9 6	9·976766	42	30
35	20	9·503360	10 62	10·496640	9·526615	10 70	10·473385	10·023255	10 7	9·976745	40	25
30	22	9·503548	11 69	10·496452	9·526824	11 77	10·473176	10·023277	11 8	9·976723	38	30
36	24	9·503735	12 75	10·496265	9·527033	12 84	10·472967	10·023298	12 9	9·976702	36	24
30	26	9·503923	13 81	10·496077	9·527242	13 90	10·472758	10·023319	13 9	9·976681	34	30
37	28	9·504110	14 87	10·495890	9·527451	14 97	10·472549	10·023340	14 10	9·976660	32	23
30	30	9·504298	15 94	10·495702	9·527660	15 104	10·472340	10·023362	15 11	9·976638	30	30
38	32	9·504485	16 100	10·495515	9·527868	16 111	10·472132	10·023383	16 11	9·976617	28	22
30	34	9·504673	17 106	10·495327	9·528077	17 118	10·471923	10·023404	17 12	9·976596	26	30
39	36	9·504860	18 112	10·495140	9·528285	18 125	10·471715	10·023426	18 13	9·976574	24	21
30	38	9·505047	19 119	10·494953	9·528494	19 132	10·471506	10·023447	19 13	9·976553	22	30
40	40	9·505234	20 125	10·494766	9·528702	20 139	10·471298	10·023468	20 14	9·976532	20	20
30	42	9·505421	21 131	10·494579	9·528910	21 146	10·471090	10·023490	21 15	9·976510	18	30
41	44	9·505608	22 137	10·494392	9·529119	22 153	10·470881	10·023511	22 16	9·976489	16	19
30	46	9·505794	23 144	10·494206	9·529327	23 160	10·470673	10·023532	23 16	9·976468	14	30
42	48	9·505981	24 150	10·494019	9·529535	24 167	10·470465	10·023554	24 17	9·976446	12	18
30	50	9·506168	25 156	10·493832	9·529743	25 174	10·470257	10·023575	25 18	9·976425	10	30
43	52	9·506354	26 162	10·493646	9·529951	26 181	10·470049	10·023596	26 18	9·976404	8	17
30	54	9·506541	27 169	10·493459	9·530158	27 188	10·469842	10·023618	27 19	9·976382	6	30
44	56	9·506727	28 175	10·493273	9·530366	28 195	10·469634	10·023639	28 20	9·976361	4	16
30	58	9·506913	29 181	10·493087	9·530574	29 202	10·469426	10·023661	29 21	9·976339	2	30
45	**15**	9·507099	30 187	10·492901	9·530781	30 209	10·469219	10·023682	30 21	9·976318	**45**	15
30	2	9·507285	1 6	10·492715	9·530989	1 7	10·469011	10·023704	1 1	9·976296	58	30
46	4	9·507471	2 12	10·492529	9·531196	2 14	10·468804	10·023725	2 1	9·976275	56	14
30	6	9·507657	3 18	10·492343	9·531403	3 21	10·468597	10·023746	3 2	9·976254	54	30
47	8	9·507843	4 25	10·492157	9·531611	4 28	10·468389	10·023768	4 3	9·976232	52	13
30	10	9·508028	5 31	10·491972	9·531818	5 34	10·468182	10·023789	5 4	9·976211	50	30
48	12	9·508214	6 37	10·491786	9·532025	6 41	10·467975	10·023811	6 4	9·976189	48	12
30	14	9·508400	7 43	10·491600	9·532232	7 48	10·467768	10·023832	7 5	9·976168	46	30
49	16	9·508585	8 49	10·491415	9·532439	8 55	10·467561	10·023854	8 6	9·976146	44	11
30	18	9·508770	9 55	10·491230	9·532646	9 62	10·467354	10·023875	9 6	9·976125	42	30
50	20	9·508956	10 62	10·491044	9·532853	10 69	10·467147	10·023897	10 7	9·976103	40	10
30	22	9·509141	11 68	10·490859	9·533059	11 76	10·466941	10·023919	11 8	9·976081	38	30
51	24	9·509326	12 74	10·490674	9·533266	12 83	10·466734	10·023940	12 9	9·976060	36	9
30	26	9·509511	13 80	10·490489	9·533472	13 89	10·466528	10·023962	13 9	9·976038	34	30
52	28	9·509696	14 86	10·490304	9·533679	14 96	10·466321	10·023983	14 10	9·976017	32	8
30	30	9·509880	15 92	10·490120	9·533885	15 103	10·466115	10·024005	15 11	9·975995	30	30
53	32	9·510065	16 99	10·489935	9·534092	16 110	10·465908	10·024026	16 12	9·975974	28	7
30	34	9·510250	17 105	10·489750	9·534298	17 117	10·465702	10·024048	17 12	9·975952	26	30
54	36	9·510434	18 111	10·489566	9·534504	18 124	10·465496	10·024070	18 13	9·975930	24	6
30	38	9·510619	19 117	10·489381	9·534710	19 131	10·465290	10·024091	19 14	9·975909	22	30
55	40	9·510803	20 123	10·489197	9·534916	20 138	10·465084	10·024113	20 14	9·975887	20	5
30	42	9·510987	21 129	10·489013	9·535122	21 144	10·464878	10·024135	21 15	9·975865	18	30
56	44	9·511172	22 135	10·488828	9·535328	22 151	10·464672	10·024156	22 16	9·975844	16	4
30	46	9·511356	23 142	10·488644	9·535534	23 158	10·464466	10·024178	23 17	9·975822	14	30
57	48	9·511540	24 148	10·488460	9·535739	24 165	10·464261	10·024200	24 17	9·975800	12	3
30	50	9·511724	25 154	10·488276	9·535945	25 172	10·464055	10·024221	25 18	9·975779	10	30
58	52	9·511907	26 160	10·488093	9·536150	26 178	10·463850	10·024243	26 19	9·975757	8	2
30	54	9·512091	27 166	10·487909	9·536356	27 186	10·463644	10·024265	27 19	9·975735	6	30
59	56	9·512275	28 172	10·487725	9·536561	28 193	10·463439	10·024286	28 20	9·975714	4	1
30	58	9·512458	29 179	10·487542	9·536767	29 200	10·463233	10·024308	29 21	9·975692	2	30
60	**16**	9·512642	30 185	10·487358	9·536972	30 206	10·463028	10·024330	30 22	9·975670	0	0
″ ‴	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	″ ‴

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LOG. SINES, COSINES, &c.

1h 16m — 19°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	″ ′
0	0	9·512642		10·487358	9·536972		10·463028	10·024330		9·975670	44	60
30	2	9·512825	1″ 6	10·487175	9·537177	1″ 7	10·462823	10·024352	1″ 1	9·975648	58	30
1	4	9·513009	2 12	10·486991	9·537382	2 14	10·462618	10·024373	2 1	9·975627	56	59
30	6	9·513192	3 18	10·486808	9·537587	3 20	10·462413	10·024395	3 2	9·975605	54	30
2	8	9·513375	4 24	10·486625	9·537792	4 27	10·462208	10·024417	4 3	9·975583	52	58
30	10	9·513558	5 30	10·486442	9·537997	5 34	10·462003	10·024439	5 4	9·975561	50	30
3	12	9·513741	6 36	10·486259	9·538202	6 41	10·461798	10·024461	6 4	9·975539	48	57
30	14	9·513924	7 43	10·486076	9·538406	7 48	10·461594	10·024482	7 5	9·975518	46	30
4	16	9·514107	8 49	10·485893	9·538611	8 54	10·461389	10·024504	8 6	9·975496	44	56
30	18	9·514289	9 55	10·485711	9·538816	9 61	10·461184	10·024526	9 7	9·975474	42	30
5	20	9·514472	10 61	10·485528	9·539020	10 68	10·460980	10·024548	10 7	9·975452	40	55
30	22	9·514655	11 67	10·485345	9·539224	11 75	10·460776	10·024570	11 8	9·975430	38	30
6	24	9·514837	12 73	10·485163	9·539429	12 82	10·460571	10·024592	12 9	9·975408	36	54
30	26	9·515019	13 79	10·484981	9·539633	13 88	10·460367	10·024614	13 9	9·975386	34	30
7	28	9·515202	14 85	10·484798	9·539837	14 95	10·460163	10·024635	14 10	9·975365	32	53
30	30	9·515384	15 91	10·484616	9·540041	15 102	10·459959	10·024657	15 11	9·975343	30	30
8	32	9·515566	16 97	10·484434	9·540245	16 109	10·459755	10·024679	16 12	9·975321	28	52
30	34	9·515748	17 103	10·484252	9·540449	17 116	10·459551	10·024701	17 12	9·975299	26	30
9	36	9·515930	18 109	10·484070	9·540653	18 122	10·459347	10·024723	18 13	9·975277	24	51
30	38	9·516112	19 115	10·483888	9·540857	19 129	10·459143	10·024745	19 14	9·975255	22	30
10	40	9·516294	20 121	10·483706	9·541061	20 136	10·458939	10·024767	20 15	9·975233	20	50
30	42	9·516475	21 127	10·483525	9·541264	21 143	10·458736	10·024789	21 15	9·975211	18	30
11	44	9·516657	22 134	10·483343	9·541468	22 150	10·458532	10·024811	22 16	9·975189	16	49
30	46	9·516838	23 140	10·483162	9·541671	23 156	10·458329	10·024833	23 17	9·975167	14	30
12	48	9·517020	24 146	10·482980	9·541875	24 163	10·458125	10·024855	24 18	9·975145	12	48
30	50	9·517201	25 152	10·482799	9·542078	25 170	10·457922	10·024877	25 18	9·975123	10	30
13	52	9·517382	26 158	10·482618	9·542281	26 177	10·457719	10·024899	26 19	9·975101	8	47
30	54	9·517564	27 164	10·482436	9·542485	27 184	10·457515	10·024921	27 20	9·975079	6	30
14	56	9·517745	28 170	10·482255	9·542688	28 190	10·457312	10·024943	28 20	9·975057	4	46
30	58	9·517926	29 176	10·482074	9·542891	29 197	10·457109	10·024965	29 21	9·975035	2	30
15	**17**	9·518107	30 182	10·481893	9·543094	30 204	10·456906	10·024987	30 22	9·975013	**43**	45
30	2	9·518287	1 6	10·481713	9·543297	1 7	10·456703	10·025009	1 1	9·974991	58	30
16	4	9·518468	2 12	10·481532	9·543499	2 13	10·456501	10·025031	2 1	9·974969	56	44
30	6	9·518649	3 18	10·481351	9·543702	3 20	10·456298	10·025053	3 2	9·974947	54	30
17	8	9·518829	4 24	10·481171	9·543905	4 27	10·456095	10·025075	4 3	9·974925	52	43
30	10	9·519010	5 30	10·480990	9·544107	5 34	10·455893	10·025098	5 4	9·974903	50	30
18	12	9·519190	6 36	10·480810	9·544310	6 40	10·455690	10·025120	6 4	9·974880	48	42
30	14	9·519371	7 42	10·480629	9·544512	7 47	10·455488	10·025142	7 5	9·974858	46	30
19	16	9·519551	8 48	10·480449	9·544715	8 54	10·455285	10·025164	8 6	9·974836	44	41
30	18	9·519731	9 54	10·480269	9·544917	9 61	10·455083	10·025186	9 7	9·974814	42	30
20	20	9·519911	10 60	10·480089	9·545119	10 67	10·454881	10·025208	10 7	9·974792	40	40
30	22	9·520091	11 66	10·479909	9·545322	11 74	10·454678	10·025230	11 8	9·974770	38	30
21	24	9·520271	12 72	10·479729	9·545524	12 81	10·454476	10·025252	12 9	9·974748	36	39
30	26	9·520451	13 78	10·479549	9·545726	13 87	10·454274	10·025275	13 10	9·974725	34	30
22	28	9·520631	14 84	10·479369	9·545928	14 94	10·454072	10·025297	14 10	9·974703	32	38
30	30	9·520810	15 90	10·479190	9·546129	15 101	10·453871	10·025319	15 11	9·974681	30	30
23	32	9·520990	16 96	10·479010	9·546331	16 108	10·453669	10·025341	16 12	9·974659	28	37
30	34	9·521169	17 102	10·478831	9·546533	17 114	10·453467	10·025364	17 13	9·974636	26	30
24	36	9·521349	18 108	10·478651	9·546735	18 121	10·453265	10·025386	18 13	9·974614	24	36
30	38	9·521528	19 114	10·478472	9·546936	19 128	10·453064	10·025408	19 14	9·974592	22	30
25	40	9·521707	20 120	10·478293	9·547138	20 135	10·452862	10·025430	20 15	9·974570	20	35
30	42	9·521887	21 126	10·478113	9·547339	21 141	10·452661	10·025453	21 16	9·974547	18	30
26	44	9·522066	22 132	10·477934	9·547540	22 148	10·452460	10·025475	22 16	9·974525	16	34
30	46	9·522245	23 138	10·477755	9·547742	23 155	10·452258	10·025497	23 17	9·974503	14	30
27	48	9·522424	24 144	10·477576	9·547943	24 162	10·452057	10·025519	24 18	9·974481	12	33
30	50	9·522602	25 150	10·477398	9·548144	25 168	10·451856	10·025542	25 18	9·974458	10	30
28	52	9·522781	26 156	10·477219	9·548345	26 175	10·451655	10·025564	26 19	9·974436	8	32
30	54	9·522960	27 162	10·477040	9·548546	27 182	10·451454	10·025586	27 20	9·974414	6	30
29	56	9·523138	28 168	10·476862	9·548747	28 188	10·451253	10·025609	28 21	9·974391	4	31
30	58	9·523317	29 174	10·476683	9·548948	29 195	10·451052	10·025631	29 21	9·974369	2	30
30	**18**	9·523495	30 180	10·476505	9·549149	30 202	10·450851	10·025653	30 22	9·974347	0	30
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	″ ′

70° — 4h 42m

LOG. SINES, COSINES, &c.

1h 18m 19°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
30	0	9·523495		10·476505	9·549149		10·450851	10·025653		9·974347	42	30
30	2	9·523674	1″ 6	10·476326	9·549349	1″ 7	10·450651	10·025676	1″ 1	9·974324	58	30
31	4	9·523852	2 12	10·476148	9·549550	2 13	10·450450	10·025698	2 1	9·974302	56	29
30	6	9·524030	3 18	10·475970	9·549751	3 20	10·450249	10·025721	3 2	9·974279	54	30
32	8	9·524208	4 24	10·475792	9·549951	4 27	10·450049	10·025743	4 3	9·974257	52	28
30	10	9·524386	5 30	10·475614	9·550152	5 33	10·449848	10·025765	5 4	9·974235	50	30
33	12	9·524564	6 35	10·475436	9·550352	6 40	10·449648	10·025788	6 4	9·974212	48	27
30	14	9·524742	7 41	10·475258	9·550552	7 47	10·449448	10·025810	7 5	9·974190	46	30
34	16	9·524920	8 47	10·475080	9·550752	8 53	10·449248	10·025833	8 6	9·974167	44	26
30	18	9·525097	9 53	10·474903	9·550952	9 60	10·449048	10·025855	9 7	9·974145	42	30
35	20	9·525275	10 59	10·474725	9·551153	10 66	10·448847	10·025878	10 7	9·974122	40	25
30	22	9·525452	11 65	10·474548	9·551353	11 73	10·448647	10·025900	11 8	9·974100	38	30
36	24	9·525630	12 71	10·474370	9·551552	12 80	10·448448	10·025923	12 9	9·974077	36	24
30	26	9·525807	13 77	10·474193	9·551752	13 86	10·448248	10·025945	13 10	9·974055	34	30
37	28	9·525984	14 83	10·474016	9·551952	14 93	10·448048	10·025968	14 10	9·974032	32	23
30	30	9·526162	15 89	10·473838	9·552152	15 98	10·447848	10·025990	15 11	9·974010	30	30
38	32	9·526339	16 94	10·473661	9·552351	16 106	10·447649	10·026013	16 12	9·973987	28	22
30	34	9·526516	17 100	10·473484	9·552551	17 113	10·447449	10·026035	17 13	9·973965	26	30
39	36	9·526693	18 106	10·473307	9·552750	18 120	10·447250	10·026058	18 13	9·973942	24	21
30	38	9·526870	19 112	10·473130	9·552950	19 126	10·447050	10·026080	19 14	9·973920	22	30
40	40	9·527046	20 118	10·472954	9·553149	20 133	10·446851	10·026103	20 15	9·973897	20	20
30	42	9·527223	21 124	10·472777	9·553348	21 140	10·446652	10·026126	21 16	9·973875	18	30
41	44	9·527400	22 130	10·472600	9·553548	22 146	10·446452	10·026148	22 16	9·973852	16	19
30	46	9·527576	23 136	10·472424	9·553747	23 153	10·446253	10·026171	23 17	9·973829	14	30
42	48	9·527753	24 142	10·472247	9·553946	24 160	10·446054	10·026193	24 18	9·973807	12	18
30	50	9·527929	25 148	10·472071	9·554145	25 166	10·445855	10·026216	25 19	9·973784	10	30
43	52	9·528105	26 153	10·471895	9·554344	26 173	10·445656	10·026239	26 19	9·973761	8	17
30	54	9·528282	27 159	10·471718	9·554543	27 180	10·445457	10·026261	27 20	9·973739	6	30
44	56	9·528458	28 165	10·471542	9·554741	28 186	10·445259	10·026284	28 21	9·973716	4	16
30	58	9·528634	29 171	10·471366	9·554940	29 193	10·445060	10·026307	29 22	9·973694	2	30
45	**19**	9·528810	30 177	10·471190	9·555139	30 199	10·444861	10·026329	30 22	9·973671	**41**	15
30	2	9·528986	1 6	10·471014	9·555337	1 7	10·444663	10·026352	1 1	9·973648	58	30
46	4	9·529161	2 12	10·470839	9·555536	2 13	10·444464	10·026375	2 2	9·973625	56	14
30	6	9·529337	3 17	10·470663	9·555734	3 20	10·444266	10·026397	3 2	9·973603	54	30
47	8	9·529513	4 23	10·470487	9·555933	4 26	10·444067	10·026420	4 3	9·973580	52	13
30	10	9·529688	5 29	10·470312	9·556131	5 33	10·443869	10·026443	5 4	9·973557	50	30
48	12	9·529864	6 35	10·470136	9·556329	6 40	10·443671	10·026465	6 5	9·973535	48	12
30	14	9·530039	7 41	10·469961	9·556527	7 46	10·443473	10·026488	7 5	9·973512	46	30
49	16	9·530215	8 47	10·469785	9·556725	8 53	10·443275	10·026511	8 6	9·973489	44	11
30	18	9·530390	9 52	10·469610	9·556923	9 59	10·443077	10·026534	9 7	9·973466	42	30
50	20	9·530565	10 58	10·469435	9·557121	10 66	10·442879	10·026556	10 8	9·973444	40	10
30	22	9·530740	11 64	10·469260	9·557319	11 72	10·442681	10·026579	11 8	9·973421	38	30
51	24	9·530915	12 70	10·469085	9·557517	12 79	10·442483	10·026602	12 9	9·973398	36	9
30	26	9·531090	13 76	10·468910	9·557715	13 86	10·442285	10·026625	13 10	9·973375	34	30
52	28	9·531265	14 81	10·468735	9·557913	14 92	10·442087	10·026648	14 10	9·973352	32	8
30	30	9·531440	15 87	10·468560	9·558110	15 99	10·441890	10·026671	15 11	9·973330	30	30
53	32	9·531614	16 93	10·468386	9·558308	16 105	10·441692	10·026693	16 12	9·973307	28	7
30	34	9·531789	17 99	10·468211	9·558505	17 112	10·441495	10·026716	17 13	9·973284	26	30
54	36	9·531963	18 105	10·468037	9·558703	18 119	10·441297	10·026739	18 14	9·973261	24	6
30	38	9·532138	19 111	10·467862	9·558900	19 125	10·441100	10·026762	19 14	9·973238	22	30
55	40	9·532312	20 117	10·467688	9·559097	20 132	10·440903	10·026785	20 15	9·973215	20	5
30	42	9·532487	21 123	10·467513	9·559294	21 138	10·440706	10·026808	21 16	9·973192	18	30
56	44	9·532661	22 128	10·467339	9·559491	22 145	10·440509	10·026831	22 17	9·973169	16	4
30	46	9·532835	23 134	10·467165	9·559688	23 152	10·440312	10·026854	23 17	9·973146	14	30
57	48	9·533009	24 140	10·466991	9·559885	24 158	10·440115	10·026876	24 18	9·973124	12	3
30	50	9·533183	25 146	10·466817	9·560082	25 165	10·439918	10·026899	25 19	9·973101	10	30
58	52	9·533357	26 152	10·466643	9·560279	26 171	10·439721	10·026922	26 20	9·973078	8	2
30	54	9·533531	27 158	10·466469	9·560476	27 178	10·439524	10·026945	27 21	9·973055	6	30
59	56	9·533704	28 164	10·466296	9·560673	28 185	10·439327	10·026968	28 21	9·973032	4	1
30	58	9·533878	29 169	10·466122	9·560869	29 191	10·439131	10·026991	29 22	9·973009	2	30
60	**20**	9·534052	30 175	10·465948	9·561066	30 198	10·438934	10·027014	30 23	9·972986	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

70° 4h 40m

LOG. SINES, COSINES, &c.

$1^h\ 20^m$ — 20°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
0	0	9·534052		10·465948	9·561066		10·438934	10·027014		9·972986	**40**	60
30	2	9·534225	1′ 6	10·465775	9·561262	1″ 7	10·438738	10·027037	1″ 1	9·972963	58	30
1	4	9·534399	2 11	10·465601	9·561459	2 13	10·438541	10·027060	2 2	9·972940	56	59
30	6	9·534572	3 17	10·465428	9·561655	3 20	10·438345	10·027083	3 2	9·972917	54	30
2	8	9·534745	4 23	10·465255	9·561851	4 26	10·438149	10·027106	4 3	9·972894	52	58
30	10	9·534918	5 29	10·465082	9·562048	5 33	10·437952	10·027129	5 4	9·972871	50	30
3	12	9·535092	6 34	10·464908	9·562244	6 39	10·437756	10·027152	6 5	9·972848	48	57
30	14	9·535265	7 40	10·464735	9·562440	7 46	10·437560	10·027175	7 5	9·972825	46	30
4	16	9·535438	8 46	10·464562	9·562636	8 52	10·437364	10·027198	8 6	9·972802	44	56
30	18	9·535610	9 52	10·464390	9·562832	9 59	10·437168	10·027222	9 7	9·972778	42	30
5	20	9·535783	10 57	10·464217	9·563028	10 65	10·436972	10·027245	10 8	9·972755	40	55
30	22	9·535956	11 63	10·464044	9·563224	11 72	10·436776	10·027268	11 8	9·972732	38	30
6	24	9·536129	12 69	10·463871	9·563419	12 78	10·436581	10·027291	12 9	9·972709	36	54
30	26	9·536301	13 75	10·463699	9·563615	13 85	10·436385	10·027314	13 10	9·972686	34	30
7	28	9·536474	14 80	10·463526	9·563811	14 91	10·436189	10·027337	14 11	9·972663	32	53
30	30	9·536646	15 86	10·463354	9·564006	15 98	10·435994	10·027360	15 12	9·972640	30	30
8	32	9·536818	16 92	10·463182	9·564202	16 104	10·435798	10·027383	16 12	9·972617	28	52
30	34	9·536991	17 98	10·463009	9·564397	17 111	10·435603	10·027407	17 13	9·972593	26	30
9	36	9·537163	18 103	10·462837	9·564593	18 117	10·435407	10·027430	18 14	9·972570	24	51
30	38	9·537335	19 109	10·462665	9·564788	19 124	10·435212	10·027453	19 15	9·972547	22	30
10	40	9·537507	20 115	10·462493	9·564983	20 130	10·435017	10·027476	20 15	9·972524	20	50
30	42	9·537679	21 121	10·462321	9·565178	21 137	10·434822	10·027499	21 16	9·972501	18	30
11	44	9·537851	22 126	10·462149	9·565373	22 143	10·434627	10·027522	22 17	9·972478	16	49
30	46	9·538023	23 132	10·461977	9·565568	23 150	10·434432	10·027546	23 18	9·972454	14	30
12	48	9·538194	24 138	10·461806	9·565763	24 156	10·434237	10·027569	24 18	9·972431	12	48
30	50	9·538366	25 144	10·461634	9·565958	25 163	10·434042	10·027592	25 19	9·972408	10	30
13	52	9·538538	26 149	10·461462	9·566153	26 170	10·433847	10·027615	26 20	9·972385	8	47
30	54	9·538709	27 155	10·461291	9·566348	27 176	10·433652	10·027639	27 21	9·972361	6	30
14	56	9·538880	28 161	10·461120	9·566542	28 183	10·433458	10·027662	28 22	9·972338	4	46
30	58	9·539052	29 167	10·460948	9·566737	29 189	10·433263	10·027685	29 22	9·972315	2	30
15	**21**	9·539223	30 172	10·460777	9·566932	30 196	10·433068	10·027709	30 23	9·972291	**39**	45
30	2	9·539394	1 6	10·460606	9·567126	1 6	10·432874	10·027732	1 1	9·972268	58	30
16	4	9·539565	2 11	10·460435	9·567320	2 13	10·432680	10·027755	2 2	9·972245	56	44
30	6	9·539736	3 17	10·460264	9·567515	3 19	10·432485	10·027779	3 2	9·972221	54	30
17	8	9·539907	4 23	10·460093	9·567709	4 26	10·432291	10·027802	4 3	9·972198	52	43
30	10	9·540078	5 28	10·459922	9·567903	5 32	10·432097	10·027825	5 4	9·972175	50	30
18	12	9·540249	6 34	10·459751	9·568098	6 39	10·431902	10·027849	6 5	9·972151	48	42
30	14	9·540420	7 40	10·459580	9·568292	7 45	10·431708	10·027872	7 5	9·972128	46	30
19	16	9·540590	8 45	10·459410	9·568486	8 52	10·431514	10·027895	8 6	9·972105	44	41
30	18	9·540761	9 51	10·459239	9·568680	9 58	10·431320	10·027919	9 7	9·972081	42	30
20	20	9·540931	10 57	10·459069	9·568873	10 64	10·431127	10·027942	10 8	9·972058	40	40
30	22	9·541102	11 62	10·458898	9·569067	11 71	10·430933	10·027966	11 9	9·972034	38	30
21	24	9·541272	12 68	10·458728	9·569261	12 77	10·430739	10·027989	12 9	9·972011	36	39
30	26	9·541442	13 74	10·458558	9·569455	13 84	10·430545	10·028012	13 10	9·971988	34	30
22	28	9·541613	14 79	10·458387	9·569648	14 90	10·430352	10·028036	14 11	9·971964	32	38
30	30	9·541783	15 85	10·458217	9·569842	15 97	10·430158	10·028059	15 12	9·971941	30	30
23	32	9·541953	16 91	10·458047	9·570035	16 103	10·429965	10·028083	16 12	9·971917	28	37
30	34	9·542123	17 96	10·457877	9·570229	17 110	10·429771	10·028106	17 13	9·971894	26	30
24	36	9·542293	18 102	10·457707	9·570422	18 116	10·429578	10·028130	18 14	9·971870	24	36
30	38	9·542462	19 108	10·457538	9·570616	19 123	10·429384	10·028153	19 15	9·971847	22	30
25	40	9·542632	20 113	10·457368	9·570809	20 129	10·429191	10·028177	20 16	9·971823	20	35
30	42	9·542802	21 119	10·457198	9·571002	21 135	10·428998	10·028200	21 16	9·971800	18	30
26	44	9·542971	22 125	10·457029	9·571195	22 142	10·428805	10·028224	22 17	9·971776	16	34
30	46	9·543141	23 130	10·456859	9·571388	23 148	10·428612	10·028247	23 18	9·971753	14	30
27	48	9·543310	24 136	10·456690	9·571581	24 155	10·428419	10·028271	24 19	9·971729	12	33
30	50	9·543480	25 142	10·456520	9·571774	25 161	10·428226	10·028294	25 19	9·971706	10	30
28	52	9·543649	26 147	10·456351	9·571967	26 168	10·428033	10·028318	26 20	9·971682	8	32
30	54	9·543818	27 153	10·456182	9·572160	27 174	10·427840	10·028342	27 21	9·971658	6	30
29	56	9·543987	28 159	10·456013	9·572352	28 181	10·427648	10·028365	28 22	9·971635	4	31
30	58	9·544156	29 164	10·455844	9·572545	29 187	10·427455	10·028389	29 23	9·971611	2	30
30	**22**	9·544325	30 170	10·455675	9·572738	30 193	10·427262	10·028412	30 23	9·971588	0	30
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

69° — $4^h\ 38^m$

LOG. SINES, COSINES, &c.

1ʰ 22ᵐ — 20°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
30	0	9·544325		10·455675	9·572738		10·427262	10·028412		9·971588	38	30
30	2	9·544494	1″ 6	10·455506	9·572930	1″ 6	10·427070	10·028436	1″ 1	9·971564	58	30
31	4	9·544663	2 11	10·455337	9·573123	2 13	10·426877	10·028460	2 1	9·971540	56	29
30	6	9·544832	3 17	10·455168	9·573315	3 19	10·426685	10·028483	3 2	9·971517	54	30
32	8	9·545000	4 22	10·455000	9·573507	4 26	10·426493	10·028507	4 3	9·971493	52	28
30	10	9·545169	5 28	10·454831	9·573700	5 32	10·426300	10·028531	5 4	9·971469	50	30
33	12	9·545338	6 34	10·454662	9·573892	6 38	10·426108	10·028554	6 5	9·971446	48	27
30	14	9·545506	7 39	10·454494	9·574084	7 45	10·425916	10·028578	7 6	9·971422	46	30
34	16	9·545674	8 45	10·454326	9·574276	8 51	10·425724	10·028602	8 6	9·971398	44	26
30	18	9·545843	9 50	10·454157	9·574468	9 58	10·425532	10·028625	9 7	9·971375	42	30
35	20	9·546011	10 56	10·453989	9·574660	10 64	10·425340	10·028649	10 8	9·971351	40	25
30	22	9·546179	11 61	10·453821	9·574852	11 70	10·425148	10·028673	11 9	9·971327	38	30
36	24	9·546347	12 67	10·453653	9·575044	12 77	10·424956	10·028697	12 9	9·971303	36	24
30	26	9·546515	13 72	10·453485	9·575236	13 83	10·424764	10·028720	13 10	9·971280	34	30
37	28	9·546683	14 78	10·453317	9·575427	14 89	10·424573	10·028744	14 11	9·971256	32	23
30	30	9·546851	15 84	10·453149	9·575619	15 96	10·424381	10·028768	15 12	9·971232	30	30
38	32	9·547019	16 90	10·452981	9·575810	16 102	10·424190	10·028792	16 13	9·971208	28	22
30	34	9·547187	17 95	10·452813	9·576002	17 109	10·423998	10·028815	17 13	9·971185	26	30
39	36	9·547354	18 101	10·452646	9·576193	18 115	10·423807	10·028839	18 14	9·971161	24	21
30	38	9·547522	19 107	10·452478	9·576385	19 121	10·423615	10·028863	19 15	9·971137	22	30
40	40	9·547689	20 112	10·452311	9·576576	20 128	10·423424	10·028887	20 16	9·971113	20	20
30	42	9·547857	21 118	10·452143	9·576767	21 134	10·423233	10·028911	21 17	9·971089	18	30
41	44	9·548024	22 123	10·451976	9·576959	22 141	10·423041	10·028934	22 17	9·971066	16	19
30	46	9·548191	23 129	10·451809	9·577150	23 147	10·422850	10·028958	23 18	9·971042	14	30
42	48	9·548359	24 134	10·451641	9·577341	24 153	10·422659	10·028982	24 19	9·971018	12	18
30	50	9·548526	25 140	10·451474	9·577532	25 160	10·422468	10·029006	25 20	9·970994	10	30
43	52	9·548693	26 145	10·451307	9·577723	26 166	10·422277	10·029030	26 21	9·970970	8	17
30	54	9·548860	27 151	10·451140	9·577914	27 173	10·422086	10·029054	27 21	9·970946	6	30
44	56	9·549027	28 156	10·450973	9·578104	28 179	10·421896	10·029078	28 22	9·970922	4	16
30	58	9·549193	29 162	10·450807	9·578295	29 185	10·421705	10·029102	29 23	9·970898	2	30
45	23	9·549360	30 168	10·450640	9·578486	30 192	10·421514	10·029126	30 24	9·970874	37	15
30	2	9·549527	1 6	10·450473	9·578676	1 6	10·421324	10·029150	1 1	9·970850	58	30
46	4	9·549693	2 11	10·450307	9·578867	2 13	10·421133	10·029173	2 2	9·970827	56	14
30	6	9·549860	3 17	10·450140	9·579057	3 19	10·420943	10·029197	3 2	9·970803	54	30
47	8	9·550026	4 22	10·449974	9·579248	4 25	10·420752	10·029221	4 3	9·970779	52	13
30	10	9·550193	5 28	10·449807	9·579438	5 32	10·420562	10·029245	5 4	9·970755	50	30
48	12	9·550359	6 33	10·449641	9·579629	6 38	10·420371	10·029269	6 5	9·970731	48	12
30	14	9·550525	7 39	10·449475	9·579819	7 44	10·420181	10·029293	7 6	9·970707	46	30
49	16	9·550692	8 44	10·449308	9·580009	8 51	10·419991	10·029317	8 6	9·970683	44	11
30	18	9·550858	9 50	10·449142	9·580199	9 57	10·419801	10·029341	9 7	9·970659	42	30
50	20	9·551024	10 55	10·448976	9·580389	10 63	10·419611	10·029365	10 8	9·970635	40	10
30	22	9·551190	11 6	10·448810	9·580579	11 70	10·419421	10·029389	11 9	9·970611	38	30
51	24	9·551356	12 66	10·448644	9·580769	12 76	10·419231	10·029414	12 10	9·970586	36	9
30	26	9·551521	13 72	10·448479	9·580959	13 82	10·419041	10·029438	13 10	9·970562	34	30
52	28	9·551687	14 77	10·448313	9·581149	14 88	10·418851	10·029462	14 11	9·970538	32	8
30	30	9·551853	15 83	10·448147	9·581339	15 95	10·418661	10·029486	15 12	9·970514	30	30
53	32	9·552018	16 88	10·447982	9·581528	16 101	10·418472	10·029510	16 13	9·970490	28	7
30	34	9·552184	17 94	10·447816	9·581718	17 107	10·418282	10·029534	17 14	9·970466	26	30
54	36	9·552349	18 99	10·447651	9·581907	18 114	10·418093	10·029558	18 14	9·970442	24	6
30	38	9·552515	19 105	10·447485	9·582097	19 120	10·417903	10·029582	19 15	9·970418	22	30
55	40	9·552680	20 110	10·447320	9·582286	20 126	10·417714	10·029606	20 16	9·970394	20	5
30	42	9·552845	21 116	10·447155	9·582476	21 133	10·417524	10·029630	21 17	9·970370	18	30
56	44	9·553010	22 121	10·446990	9·582665	22 139	10·417335	10·029655	22 18	9·970345	16	4
30	46	9·553176	23 127	10·446824	9·582854	23 145	10·417146	10·029679	23 18	9·970321	14	30
57	48	9·553341	24 132	10·446659	9·583044	24 152	10·416956	10·029703	24 19	9·970297	12	3
30	50	9·553506	25 138	10·446494	9·583233	25 158	10·416767	10·029727	25 20	9·970273	10	30
58	52	9·553670	26 143	10·446330	9·583422	26 164	10·416578	10·029751	26 21	9·970249	8	2
30	54	9·553835	27 149	10·446165	9·583611	27 171	10·416389	10·029776	27 22	9·970224	6	30
59	56	9·554000	28 154	10·446000	9·583800	28 177	10·416200	10·029800	28 22	9·970200	4	1
30	58	9·554165	29 160	10·445835	9·583989	29 183	10·416011	10·029824	29 23	9·970176	2	30
60	24	9·554329	30 166	10·445671	9·584177	30 190	10·415823	10·029848	30 24	9·970152	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

69° — 4ʰ 36ᵐ

LOG. SINES, COSINES, &c.

1ʰ 24ᵐ 21°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
0	0	9·554329		10·445671	9·584177		10·415823	10·029848		9·970152	**36**	60
30	2	9·554494	1″ 5	10·445506	9·584366	1″ 6	10·415634	10·029873	1″ 1	9·970127	58	30
1	4	9·554658	2 11	10·445342	9·584555	2 13	10·415445	10·029897	2 2	9·970103	56	59
30	6	9·554822	3 16	10·445178	9·584744	3 19	10·415256	10·029921	3 2	9·970079	54	30
2	8	9·554987	4 22	10·445013	9·584932	4 25	10·415068	10·029945	4 3	9·970055	52	58
30	10	9·555151	5 27	10·444849	9·585121	5 31	10·414879	10·029970	5 4	9·970030	50	30
3	12	9·555315	6 33	10·444685	9·585309	6 38	10·414691	10·029994	6 5	9·970006	48	57
30	14	9·555479	7 38	10·444521	9·585498	7 44	10·414502	10·030018	7 6	9·969982	46	30
4	16	9·555643	8 44	10·444357	9·585686	8 50	10·414314	10·030043	8 7	9·969957	44	56
30	18	9·555807	9 49	10·444193	9·585874	9 56	10·414126	10·030067	9 7	9·969933	42	30
5	20	9·555971	10 54	10·444029	9·586062	10 63	10·413938	10·030091	10 8	9·969909	40	55
30	22	9·556135	11 60	10·443865	9·586251	11 69	10·413749	10·030116	11 9	9·969884	38	30
6	24	9·556299	12 65	10·443701	9·586439	12 75	10·413561	10·030140	12 10	9·969860	36	54
30	26	9·556462	13 71	10·443538	9·586627	13 81	10·413373	10·030164	13 11	9·969836	34	30
7	28	9·556626	14 76	10·443374	9·586815	14 88	10·413185	10·030189	14 11	9·969811	32	53
30	30	9·556789	15 82	10·443211	9·587003	15 94	10·412997	10·030213	15 12	9·969787	30	30
8	32	9·556953	16 87	10·443047	9·587190	16 100	10·412810	10·030238	16 13	9·969762	28	52
30	34	9·557116	17 93	10·442884	9·587378	17 106	10·412622	10·030262	17 14	9·969738	26	30
9	36	9·557280	18 98	10·442720	9·587566	18 113	10·412434	10·030286	18 15	9·969714	24	51
30	38	9·557443	19 104	10·442557	9·587754	19 119	10·412246	10·030311	19 15	9·969689	22	30
10	40	9·557606	20 109	10·442394	9·587941	20 125	10·412059	10·030335	20 16	9·969665	20	50
30	42	9·557769	21 115	10·442231	9·588129	21 131	10·411871	10·030360	21 17	9·969640	18	30
11	44	9·557932	22 120	10·442068	9·588316	22 138	10·411684	10·030384	22 18	9·969616	16	49
30	46	9·558095	23 126	10·441905	9·588504	23 144	10·411496	10·030409	23 19	9·969591	14	30
12	48	9·558258	24 131	10·441742	9·588691	24 150	10·411309	10·030433	24 19	9·969567	12	48
30	50	9·558421	25 137	10·441579	9·588878	25 156	10·411122	10·030458	25 20	9·969542	10	30
13	52	9·558583	26 142	10·441417	9·589066	26 163	10·410934	10·030482	26 21	9·969518	8	47
30	54	9·558746	27 147	10·441254	9·589253	27 169	10·410747	10·030507	27 22	9·969493	6	30
14	56	9·558909	28 153	10·441091	9·589440	28 175	10·410560	10·030531	28 23	9·969469	4	46
30	58	9·559071	29 158	10·440929	9·589627	29 182	10·410373	10·030556	29 23	9·969444	2	30
15	**25**	9·559234	30 163	10·440766	9·589814	30 188	10·410186	10·030580	30 24	9·969420	**35**	45
30	2	9·559396	1 5	10·440604	9·590001	1 6	10·409999	10·030605	1 1	9·969395	58	30
16	4	9·559558	2 11	10·440442	9·590188	2 12	10·409812	10·030630	2 2	9·969370	56	44
30	6	9·559721	3 16	10·440279	9·590375	3 19	10·409625	10·030654	3 2	9·969346	54	30
17	8	9·559883	4 22	10·440117	9·590562	4 25	10·409438	10·030679	4 3	9·969321	52	43
30	10	9·560045	5 27	10·439955	9·590748	5 31	10·409252	10·030703	5 4	9·969297	50	30
18	12	9·560207	6 32	10·439793	9·590935	6 37	10·409065	10·030728	6 5	9·969272	48	42
30	14	9·560369	7 38	10·439631	9·591122	7 43	10·408878	10·030753	7 6	9·969247	46	30
19	16	9·560531	8 43	10·439469	9·591308	8 50	10·408692	10·030777	8 7	9·969223	44	41
30	18	9·560693	9 48	10·439307	9·591495	9 56	10·408505	10·030802	9 7	9·969198	42	30
20	20	9·560855	10 54	10·439145	9·591681	10 62	10·408319	10·030827	10 8	9·969173	40	40
30	22	9·561016	11 59	10·438984	9·591867	11 68	10·408132	10·030851	11 9	9·969149	38	30
21	24	9·561178	12 65	10·438822	9·592054	12 74	10·407946	10·030876	12 10	9·969124	36	39
30	26	9·561339	13 70	10·438661	9·592240	13 81	10·407760	10·030901	13 11	9·969099	34	30
22	28	9·561501	14 75	10·438499	9·592426	14 87	10·407574	10·030925	14 11	9·969075	32	38
30	30	9·561662	15 81	10·438338	9·592612	15 93	10·407388	10·030950	15 12	9·969050	30	30
23	32	9·561824	16 86	10·438176	9·592799	16 99	10·407201	10·030975	16 13	9·969025	28	37
30	34	9·561985	17 91	10·438015	9·592985	17 105	10·407015	10·031000	17 14	9·969000	26	30
24	36	9·562146	18 97	10·437854	9·593171	18 112	10·406829	10·031024	18 15	9·968976	24	36
30	38	9·562307	19 102	10·437693	9·593356	19 118	10·406644	10·031049	19 16	9·968951	22	30
25	40	9·562468	20 108	10·437532	9·593542	20 124	10·406458	10·031074	20 16	9·968926	20	35
30	42	9·562629	21 113	10·437371	9·593728	21 130	10·406272	10·031099	21 17	9·968901	18	30
26	44	9·562790	22 119	10·437210	9·593914	22 136	10·406086	10·031123	22 18	9·968877	16	34
30	46	9·562951	23 124	10·437049	9·594099	23 143	10·405901	10·031148	23 19	9·968852	14	30
27	48	9·563112	24 129	10·436888	9·594285	24 149	10·405715	10·031173	24 20	9·968827	12	33
30	50	9·563273	25 135	10·436727	9·594471	25 155	10·405529	10·031198	25 20	9·968802	[illegible]	[illegible]
28	52	9·563433	26 140	10·436567	9·594656	26 161	10·405344	10·031223	26 21	9·968777	8	32
30	54	9·563594	27 145	10·436406	9·594842	27 167	10·405158	10·031248	27 22	9·968752	6	30
29	56	9·563755	28 151	10·436245	9·595027	28 174	10·404973	10·031272	28 23	9·968728	4	31
30	58	9·563915	29 156	10·436085	9·595212	29 180	10·404788	10·031297	29 24	9·968703	2	30
30	**26**	9·564075	30 161	10·435925	9·595398	30 186	10·404602	10·031322	30 25	9·968678	0	30
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

68° 4ʰ 34ᵐ

LOG. SINES, COSINES, &c.

$1^h\ 26^m$ — 21°

′ ″	m.	Sine	Parts	Cosec	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
30	0	9.564075		10.435925	9.595398		10.404602	10.031322		9.968678	34	30
30	2	9.564236	1″ 5	10.435764	9.595583	1″ 6	10.404417	10.031347	1″ 1	9.968653	58	30
31	4	9.564396	2 11	10.435604	9.595768	2 12	10.404232	10.031372	2 2	9.968628	56	29
30	6	9.564556	3 16	10.435444	9.595953	3 18	10.404047	10.031397	3 3	9.968603	54	30
32	8	9.564716	4 21	10.435284	9.596138	4 25	10.403862	10.031422	4 3	9.968578	52	28
30	10	9.564876	5 27	10.435124	9.596323	5 31	10.403677	10.031447	5 4	9.968553	50	30
33	12	9.565036	6 32	10.434964	9.596508	6 37	10.403492	10.031472	6 5	9.968528	48	27
30	14	9.565196	7 37	10.434804	9.596693	7 43	10.403307	10.031497	7 6	9.968503	46	30
34	16	9.565356	8 42	10.434644	9.596878	8 49	10.403122	10.031521	8 7	9.968479	44	26
30	18	9.565516	9 48	10.434484	9.597062	9 55	10.402938	10.031546	9 8	9.968454	42	30
35	20	9.565676	10 53	10.434324	9.597247	10 61	10.402753	10.031571	10 8	9.968429	40	25
30	22	9.565835	11 58	10.434165	9.597432	11 68	10.402568	10.031596	11 9	9.968404	38	30
36	24	9.565995	12 64	10.434005	9.597616	12 74	10.402384	10.031621	12 10	9.968379	36	24
30	26	9.566154	13 69	10.433846	9.597801	13 80	10.402199	10.031646	13 11	9.968354	34	30
37	28	9.566314	14 74	10.433686	9.597985	14 86	10.402015	10.031671	14 12	9.968329	32	23
30	30	9.566473	15 80	10.433527	9.598170	15 92	10.401830	10.031697	15 12	9.968303	30	30
38	32	9.566632	16 85	10.433368	9.598354	16 98	10.401646	10.031722	16 13	9.968278	28	22
30	34	9.566792	17 90	10.433208	9.598538	17 105	10.401462	10.031747	17 14	9.968253	26	30
39	36	9.566951	18 96	10.433049	9.598722	18 111	10.401278	10.031772	18 15	9.968228	24	21
30	38	9.567110	19 101	10.432890	9.598907	19 117	10.401093	10.031797	19 16	9.968203	22	30
40	40	9.567269	20 106	10.432731	9.599091	20 123	10.400909	10.031822	20 17	9.968178	20	20
30	42	9.567428	21 112	10.432572	9.599275	21 129	10.400725	10.031847	21 17	9.968153	18	30
41	44	9.567587	22 117	10.432413	9.599459	22 135	10.400541	10.031872	22 18	9.968128	16	19
30	46	9.567746	23 122	10.432254	9.599643	23 141	10.400357	10.031897	23 19	9.968103	14	30
42	48	9.567904	24 127	10.432096	9.599827	24 148	10.400173	10.031922	24 20	9.968078	12	18
30	50	9.568063	25 133	10.431937	9.600011	25 154	10.399989	10.031947	25 21	9.968053	10	30
43	52	9.568222	26 138	10.431778	9.600194	26 160	10.399806	10.031973	26 22	9.968027	8	17
30	54	9.568380	27 143	10.431620	9.600378	27 166	10.399622	10.031998	27 22	9.968002	6	30
44	56	9.568539	28 149	10.431461	9.600562	28 172	10.399438	10.032023	28 23	9.967977	4	16
30	58	9.568697	29 154	10.431303	9.600745	29 178	10.399255	10.032048	29 24	9.967952	2	30
45	**27**	9.568856	30 159	10.431144	9.600929	30 184	10.399071	10.032073	30 25	9.967927	**33**	15
30	2	9.569014	1 5	10.430986	9.601112	1 6	10.398888	10.032099	1 1	9.967901	58	30
46	4	9.569172	2 10	10.430828	9.601296	2 12	10.398704	10.032124	2 2	9.967876	56	14
30	6	9.569330	3 16	10.430670	9.601479	3 18	10.398521	10.032149	3 3	9.967851	54	30
47	8	9.569488	4 21	10.430512	9.601663	4 24	10.398337	10.032174	4 3	9.967826	52	13
30	10	9.569646	5 26	10.430354	9.601846	5 30	10.398154	10.032199	5 4	9.967801	50	30
48	12	9.569804	6 31	10.430196	9.602029	6 37	10.397971	10.032225	6 5	9.967775	48	12
30	14	9.569962	7 37	10.430038	9.602212	7 43	10.397788	10.032250	7 6	9.967750	46	30
49	16	9.570120	8 42	10.429880	9.602395	8 49	10.397605	10.032275	8 7	9.967725	44	11
30	18	9.570278	9 47	10.429722	9.602578	9 55	10.397422	10.032301	9 8	9.967699	42	30
50	20	9.570435	10 52	10.429565	9.602761	10 61	10.397239	10.032326	10 8	9.967674	40	10
30	22	9.570593	11 58	10.429407	9.602944	11 67	10.397056	10.032351	11 9	9.967649	38	30
51	24	9.570751	12 63	10.429249	9.603127	12 73	10.396873	10.032376	12 10	9.967624	36	9
30	26	9.570908	13 68	10.429092	9.603310	13 79	10.396690	10.032402	13 11	9.967598	34	30
52	28	9.571066	14 73	10.428934	9.603493	14 85	10.396507	10.032427	14 12	9.967573	32	8
30	30	9.571223	15 79	10.428777	9.603675	15 91	10.396325	10.032453	15 13	9.967547	30	30
53	32	9.571380	16 84	10.428620	9.603858	16 97	10.396142	10.032478	16 14	9.967522	28	7
30	34	9.571537	17 89	10.428463	9.604041	17 104	10.395959	10.032503	17 14	9.967497	26	30
54	36	9.571695	18 95	10.428305	9.604223	18 110	10.395777	10.032529	18 15	9.967471	24	6
30	38	9.571852	19 100	10.428148	9.604406	19 116	10.395594	10.032554	19 16	9.967446	22	30
55	40	9.572009	20 105	10.427991	9.604588	20 122	10.395412	10.032579	20 17	9.967421	20	5
30	42	9.572166	21 110	10.427834	9.604771	21 128	10.395229	10.032605	21 18	9.967395	18	30
56	44	9.572323	22 116	10.427677	9.604953	22 134	10.395047	10.032630	22 19	9.967370	16	4
30	46	9.572479	23 121	10.427521	9.605135	23 140	10.394865	10.032656	23 20	9.967344	14	30
57	48	9.572636	24 126	10.427364	9.605317	24 146	10.394683	10.032681	24 20	9.967319	12	3
30	50	9.572793	25 131	10.427207	9.605500	25 152	10.394500	10.032707	25 21	9.967293	10	30
58	52	9.572950	26 137	10.427050	9.605682	26 158	10.394318	10.032732	26 22	9.967268	8	2
30	54	9.573106	27 142	10.426894	9.605864	27 164	10.394136	10.032758	27 23	9.967242	6	30
59	56	9.573263	28 147	10.426737	9.606046	28 171	10.393954	10.032783	28 24	9.967217	4	1
30	58	9.573419	29 152	10.426581	9.606228	29 177	10.393772	10.032809	29 25	9.967191	2	30
60	**28**	9.573575	30 157	10.426425	9.606410	30 183	10.393590	10.032834	30 25	9.967166	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	

68° — $4^h\ 32^m$

LOG. SINES, COSINES, &c.

1h 28m — 22°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
0	0	9·573575		10·426425	9·606410		10·393590	10·032834		9·967166	32	60
30	2	9·573732	1″ 5	10·426268	9·606591	1″ 6	10·393409	10·032860	1″ 1	9·967140	58	30
1	4	9·573888	2 10	10·426112	9·606773	2 12	10·393227	10·032885	2 2	9·967115	56	59
30	6	9·574044	3 16	10·425956	9·606955	3 18	10·393045	10·032911	3 3	9·967089	54	30
2	8	9·574200	4 21	10·425800	9·607137	4 24	10·392863	10·032936	4 3	9·967064	52	58
30	10	9·574356	5 26	10·425644	9·607318	5 30	10·392682	10·032962	5 4	9·967038	50	30
3	12	9·574512	6 31	10·425488	9·607500	6 36	10·392500	10·032987	6 5	9·967013	48	57
30	14	9·574668	7 36	10·425332	9·607681	7 42	10·392319	10·033013	7 6	9·966987	46	30
4	16	9·574824	8 41	10·425176	9·607863	8 48	10·392137	10·033039	8 7	9·966961	44	56
30	18	9·574980	9 47	10·425020	9·608044	9 54	10·391956	10·033064	9 8	9·966936	42	30
5	20	9·575136	10 52	10·424864	9·608225	10 60	10·391775	10·033090	10 9	9·966910	40	55
30	22	9·575291	11 57	10·424709	9·608407	11 66	10·391593	10·033116	11 9	9·966884	38	30
6	24	9·575447	12 62	10·424553	9·608588	12 72	10·391412	10·033141	12 10	9·966859	36	54
30	26	9·575602	13 67	10·424398	9·608769	13 78	10·391231	10·033167	13 11	9·966833	34	30
7	28	9·575758	14 73	10·424242	9·608950	14 84	10·391050	10·033192	14 12	9·966808	32	53
30	30	9·575913	15 78	10·424087	9·609131	15 90	10·390869	10·033218	15 13	9·966782	30	30
8	32	9·576069	16 83	10·423931	9·609312	16 96	10·390688	10·033244	16 14	9·966756	28	52
30	34	9·576224	17 88	10·423776	9·609493	17 103	10·390507	10·033270	17 14	9·966730	26	30
9	36	9·576379	18 93	10·423621	9·609674	18 109	10·390326	10·033295	18 15	9·966705	24	51
30	38	9·576534	19 99	10·423466	9·609855	19 115	10·390145	10·033321	19 16	9·966679	22	30
10	40	9·576689	20 104	10·423311	9·610036	20 121	10·389964	10·033347	20 17	9·966653	20	50
30	42	9·576844	21 109	10·423156	9·610217	21 127	10·389783	10·033372	21 18	9·966628	18	30
11	44	9·576999	22 114	10·423001	9·610397	22 133	10·389603	10·033398	22 19	9·966602	16	49
30	46	9·577154	23 119	10·422846	9·610578	23 139	10·389422	10·033424	23 20	9·966576	14	30
12	48	9·577309	24 124	10·422691	9·610759	24 145	10·389241	10·033450	24 21	9·966550	12	48
30	50	9·577464	25 130	10·422536	9·610939	25 151	10·389061	10·033475	25 21	9·966525	10	30
13	52	9·577618	26 135	10·422382	9·611120	26 157	10·388880	10·033501	26 22	9·966499	8	47
30	54	9·577773	27 140	10·422227	9·611300	27 163	10·388700	10·033527	27 23	9·966473	6	30
14	56	9·577927	28 145	10·422073	9·611480	28 169	10·388520	10·033553	28 24	9·966447	4	46
30	58	9·578082	29 150	10·421918	9·611661	29 175	10·388339	10·033579	29 25	9·966421	2	30
15	**29**	9·578236	30 155	10·421764	9·611841	30 181	10·388159	10·033605	30 26	9·966395	**31**	45
30	2	9·578391	1 5	10·421609	9·612021	1 6	10·387979	10·033630	1 1	9·966370	58	30
16	4	9·578545	2 10	10·421455	9·612201	2 12	10·387799	10·033656	2 2	9·966344	56	44
30	6	9·578699	3 15	10·421301	9·612381	3 18	10·387619	10·033682	3 3	9·966318	54	30
17	8	9·578853	4 20	10·421147	9·612561	4 24	10·387439	10·033708	4 3	9·966292	52	43
30	10	9·579008	5 26	10·420992	9·612741	5 30	10·387259	10·033734	5 4	9·966266	50	30
18	12	9·579162	6 31	10·420838	9·612921	6 36	10·387079	10·033760	6 5	9·966240	48	42
30	14	9·579316	7 36	10·420684	9·613101	7 42	10·386899	10·033786	7 6	9·966214	46	30
19	16	9·579470	8 41	10·420530	9·613281	8 48	10·386719	10·033812	8 7	9·966188	44	41
30	18	9·579623	9 46	10·420377	9·613461	9 54	10·386539	10·033838	9 8	9·966162	42	30
20	20	9·579777	10 51	10·420223	9·613641	10 60	10·386359	10·033864	10 9	9·966136	40	40
30	22	9·579931	11 56	10·420069	9·613820	11 66	10·386180	10·033890	11 10	9·966110	38	30
21	24	9·580085	12 61	10·419915	9·614000	12 72	10·386000	10·033915	12 10	9·966085	36	39
30	26	9·580238	13 66	10·419762	9·614180	13 78	10·385820	10·033941	13 11	9·966059	34	30
22	28	9·580392	14 71	10·419608	9·614359	14 84	10·385641	10·033967	14 12	9·966033	32	38
30	30	9·580545	15 77	10·419455	9·614539	15 90	10·385461	10·033993	15 13	9·966007	30	30
23	32	9·580699	16 82	10·419301	9·614718	16 96	10·385282	10·034019	16 14	9·965981	28	37
30	34	9·580852	17 87	10·419148	9·614897	17 102	10·385103	10·034045	17 15	9·965955	26	30
24	36	9·581005	18 92	10·418995	9·615077	18 108	10·384923	10·034071	18 16	9·965929	24	36
30	38	9·581158	19 97	10·418842	9·615256	19 114	10·384744	10·034098	19 17	9·965902	22	30
25	40	9·581312	20 102	10·418688	9·615435	20 120	10·384565	10·034124	20 17	9·965876	20	35
30	42	9·581465	21 107	10·418535	9·615614	21 126	10·384386	10·034150	21 18	9·965850	18	30
26	44	9·581618	22 112	10·418382	9·615793	22 132	10·384207	10·034176	22 19	9·965824	16	34
30	46	9·581771	23 118	10·418229	9·615972	23 138	10·384028	10·034202	23 20	9·965798	14	30
27	48	9·581924	24 123	10·418076	9·616151	24 144	10·383849	10·034228	24 21	9·965772	12	33
30	50	9·582076	25 128	10·417924	9·616330	25 149	10·383670	10·034254	25 22	9·965746	10	30
28	52	9·582229	26 133	10·417771	9·616509	26 155	10·383491	10·034280	26 23	9·965720	8	32
30	54	9·582382	27 138	10·417618	9·616688	27 161	10·383312	10·034306	27 23	9·965694	6	30
29	56	9·582535	28 143	10·417465	9·616867	28 167	10·383133	10·034332	28 24	9·965668	4	31
30	58	9·582687	29 148	10·417313	9·617046	29 173	10·382954	10·034358	29 25	9·965642	2	30
30	**30**	9·582840	30 153	10·417160	9·617224	30 179	10·382776	10·034385	30 26	9·965615	0	30
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

67° — 4h 30m

LOG. SINES, COSINES, &c.

1ʰ 30ᵐ — 22°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
30	0	9·582840		10·417160	9·617224		10·382776	10·034385		9·965615	**30**	30
30	2	9·582992	1″ 5	10·417008	9·617403	1″ 6	10·382597	10·034411	1″ 1	9·965589	58	30
31	4	9·583145	2 10	10·416855	9·617582	2 12	10·382418	10·034437	2 2	9·965563	56	29
30	6	9·583297	3 15	10·416703	9·617760	3 18	10·382240	10·034463	3 3	9·965537	54	30
32	8	9·583449	4 20	10·416551	9·617939	4 24	10·382061	10·034489	4 4	9·965511	52	28
30	10	9·583601	5 25	10·416399	9·618117	5 30	10·381883	10·034516	5 4	9·965484	50	30
33	12	9·583754	6 30	10·416246	9·618295	6 36	10·381705	10·034542	6 5	9·965458	48	27
30	14	9·583906	7 35	10·416094	9·618474	7 42	10·381526	10·034568	7 6	9·965432	46	30
34	16	9·584058	8 40	10·415942	9·618652	8 47	10·381348	10·034594	8 7	9·965406	44	26
30	18	9·584210	9 45	10·415790	9·618830	9 53	10·381170	10·034621	9 8	9·965379	42	30
35	20	9·584361	10 50	10·415639	9·619008	10 59	10·380992	10·034647	10 9	9·965353	40	25
30	22	9·584513	11 56	10·415487	9·619186	11 65	10·380814	10·034673	11 10	9·965327	38	30
36	24	9·584665	12 61	10·415335	9·619364	12 71	10·380636	10·034699	12 11	9·965301	36	24
30	26	9·584817	13 66	10·415183	9·619543	13 77	10·380457	10·034726	13 11	9·965274	34	30
37	28	9·584968	14 71	10·415032	9·619720	14 83	10·380280	10·034752	14 12	9·965248	32	23
30	30	9·585120	15 76	10·414880	9·619898	15 90	10·380102	10·034778	15 13	9·965222	30	30
38	32	9·585272	16 81	10·414728	9·620076	16 95	10·379924	10·034805	16 14	9·965195	28	22
30	34	9·585423	17 86	10·414577	9·620254	17 101	10·379746	10·034831	17 15	9·965169	26	30
39	36	9·585574	18 91	10·414426	9·620432	18 107	10·379568	10·034857	18 16	9·965143	24	21
30	38	9·585726	19 96	10·414274	9·620610	19 113	10·379390	10·034884	19 17	9·965116	22	30
40	40	9·585877	20 101	10·414123	9·620787	20 119	10·379213	10·034910	20 18	9·965090	20	20
30	42	9·586028	21 106	10·413972	9·620965	21 125	10·379035	10·034936	21 18	9·965064	18	30
41	44	9·586179	22 111	10·413821	9·621142	22 130	10·378858	10·034963	22 19	9·965037	16	19
30	46	9·586331	23 116	10·413669	9·621320	23 136	10·378680	10·034989	23 20	9·965011	14	30
42	48	9·586482	24 121	10·413518	9·621497	24 142	10·378503	10·035016	24 21	9·964984	12	18
30	50	9·586633	25 126	10·413367	9·621675	25 148	10·378325	10·035042	25 22	9·964958	10	30
43	52	9·586783	26 131	10·413217	9·621852	26 154	10·378148	10·035069	26 23	9·964931	8	17
30	54	9·586934	27 136	10·413066	9·622029	27 160	10·377971	10·035095	27 24	9·964905	6	30
44	56	9·587085	28 141	10·412915	9·622207	28 166	10·377793	10·035121	28 25	9·964879	4	16
30	58	9·587236	29 146	10·412764	9·622384	29 172	10·377616	10·035148	29 26	9·964852	2	30
45	**31**	9·587386	30 151	10·412614	9·622561	30 178	10·377439	10·035174	30 26	9·964826	**29**	15
30	2	9·587537	1 5	10·412463	9·622738	1 6	10·377262	10·035201	1 1	9·964799	58	30
46	4	9·587688	2 10	10·412312	9·622915	2 12	10·377085	10·035227	2 2	9·964773	56	14
30	6	9·587838	3 15	10·412162	9·623092	3 18	10·376908	10·035254	3 3	9·964746	54	30
47	8	9·587989	4 20	10·412011	9·623269	4 24	10·376731	10·035280	4 4	9·964720	52	13
30	10	9·588139	5 25	10·411861	9·623446	5 29	10·376554	10·035307	5 4	9·964693	50	30
48	12	9·588289	6 30	10·411711	9·623623	6 35	10·376377	10·035334	6 5	9·964666	48	12
30	14	9·588439	7 35	10·411561	9·623800	7 41	10·376200	10·035360	7 6	9·964640	46	30
49	16	9·588590	8 40	10·411410	9·623976	8 47	10·376024	10·035387	8 7	9·964613	44	11
30	18	9·588740	9 45	10·411260	9·624153	9 53	10·375847	10·035413	9 8	9·964587	42	30
50	20	9·588890	10 50	10·411110	9·624330	10 59	10·375670	10·035440	10 9	9·964560	40	10
30	22	9·589040	11 55	10·410960	9·624506	11 65	10·375494	10·035466	11 10	9·964534	38	30
51	24	9·589190	12 60	10·410810	9·624683	12 71	10·375317	10·035493	12 11	9·964507	36	9
30	26	9·589340	13 65	10·410660	9·624859	13 76	10·375141	10·035520	13 12	9·964480	34	30
52	28	9·589489	14 70	10·410511	9·625036	14 82	10·374964	10·035546	14 12	9·964454	32	8
30	30	9·589639	15 75	10·410361	9·625212	15 88	10·374788	10·035573	15 13	9·964427	30	30
53	32	9·589789	16 80	10·410211	9·625388	16 94	10·374612	10·035600	16 14	9·964400	28	7
30	34	9·589938	17 85	10·410062	9·625565	17 100	10·374435	10·035626	17 15	9·964374	26	30
54	36	9·590088	18 90	10·409912	9·625741	18 106	10·374259	10·035653	18 16	9·964347	24	6
30	38	9·590237	19 95	10·409763	9·625917	19 112	10·374083	10·035680	19 17	9·964320	22	30
55	40	9·590387	20 100	10·409613	9·626093	20 118	10·373907	10·035706	20 18	9·964294	20	5
30	42	9·590536	21 105	10·409464	9·626269	21 123	10·373731	10·035733	21 19	9·964267	18	30
56	44	9·590686	22 110	10·409314	9·626445	22 129	10·373555	10·035760	22 20	9·964240	16	4
30	46	9·590835	23 115	10·409165	9·626621	23 135	10·373379	10·035786	23 20	9·964214	14	30
57	48	9·590984	24 120	10·409016	9·626797	24 141	10·373203	10·035813	24 21	9·964187	12	3
30	50	9·591133	25 125	10·408867	9·626973	25 147	10·373027	10·035840	25 22	9·964160	10	30
58	52	9·591282	26 130	10·408718	9·627149	26 153	10·372851	10·035867	26 23	9·964133	8	2
30	54	9·591431	27 135	10·408569	9·627325	27 159	10·372675	10·035894	27 24	9·964106	6	30
59	56	9·591580	28 140	10·408420	9·627501	28 165	10·372499	10·035920	28 25	9·964080	4	1
30	58	9·591729	29 145	10·408271	9·627676	29 171	10·372324	10·035947	29 26	9·964053	2	30
60	**32**	9·591878	30 150	10·408122	9·627852	30 176	10·372148	10·035974	30 27	9·964026	0	0
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

67° — 4ʰ 28ᵐ

LOG. SINES, COSINES, &c.

1h 32m — 23°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·591878		10·408122	9·627852		10·372148	10·035974		9·964026	28	60
30	2	9·592027	1″ 5	10·407973	9·628028	1″ 6	10·371972	10·036001	1″ 1	9·963999	58	30
1	4	9·592176	2 10	10·407824	9·628203	2 12	10·371797	10·036028	2 2	9·963972	56	59
30	6	9·592324	3 15	10·407676	9·628379	3 17	10·371621	10·036054	3 3	9·963946	54	30
2	8	9·592473	4 20	10·407527	9·628554	4 23	10·371446	10·036081	4 4	9·963919	52	58
30	10	9·592621	5 25	10·407379	9·628729	5 29	10·371271	10·036108	5 4	9·963892	50	30
3	12	9·592770	6 30	10·407230	9·628905	6 35	10·371095	10·036135	6 5	9·963865	48	57
30	14	9·592918	7 35	10·407082	9·629080	7 41	10·370920	10·036162	7 6	9·963838	46	30
4	16	9·593067	8 39	10·406933	9·629255	8 47	10·370745	10·036189	8 7	9·963811	44	56
30	18	9·593215	9 44	10·406785	9·629431	9 52	10·370569	10·036216	9 8	9·963784	42	30
5	20	9·593363	10 49	10·406637	9·629606	10 58	10·370394	10·036243	10 9	9·963757	40	55
30	22	9·593511	11 54	10·406489	9·629781	11 64	10·370219	10·036270	11 10	9·963730	38	30
6	24	9·593659	12 59	10·406341	9·629956	12 70	10·370044	10·036296	12 11	9·963704	36	54
30	26	9·593807	13 64	10·406193	9·630131	13 76	10·369869	10·036323	13 12	9·963677	34	30
7	28	9·593955	14 69	10·406045	9·630306	14 82	10·369694	10·036350	14 13	9·963650	32	53
30	30	9·594103	15 74	10·405897	9·630481	15 87	10·369519	10·036377	15 13	9·963623	30	30
8	32	9·594251	16 79	10·405749	9·630656	16 93	10·369344	10·036404	16 14	9·963596	28	52
30	34	9·594399	17 84	10·405601	9·630830	17 99	10·369170	10·036431	17 15	9·963569	26	30
9	36	9·594547	18 89	10·405453	9·631005	18 105	10·368995	10·036458	18 16	9·963542	24	51
30	38	9·594695	19 94	10·405305	9·631180	19 111	10·368820	10·036485	19 17	9·963515	22	30
10	40	9·594842	20 99	10·405158	9·631355	20 117	10·368645	10·036512	20 18	9·963488	20	50
30	42	9·594990	21 104	10·405010	9·631529	21 122	10·368471	10·036539	21 19	9·963461	18	30
11	44	9·595137	22 109	10·404863	9·631704	22 128	10·368296	10·036566	22 20	9·963434	16	49
30	46	9·595285	23 114	10·404715	9·631878	23 134	10·368122	10·036593	23 21	9·963407	14	30
12	48	9·595432	24 118	10·404568	9·632053	24 140	10·367947	10·036621	24 22	9·963379	12	48
30	50	9·595580	25 123	10·404420	9·632227	25 146	10·367773	10·036648	25 22	9·963352	10	30
13	52	9·595727	26 128	10·404273	9·632402	26 152	10·367598	10·036675	26 23	9·963325	8	47
30	54	9·595874	27 133	10·404126	9·632576	27 157	10·367424	10·036702	27 24	9·963298	6	30
14	56	9·596021	28 138	10·403979	9·632750	28 163	10·367250	10·036729	28 25	9·963271	4	46
30	58	9·596168	29 143	10·403832	9·632924	29 169	10·367076	10·036756	29 26	9·963244	2	30
15	**33**	9·596315	30 148	10·403685	9·633099	30 175	10·366901	10·036783	30 27	9·963217	**27**	45
30	2	9·596462	1 5	10·403538	9·633273	1 6	10·366727	10·036810	1 1	9·963190	58	30
16	4	9·596609	2 10	10·403391	9·633447	2 12	10·366553	10·036837	2 2	9·963163	56	44
30	6	9·596756	3 15	10·403244	9·633621	3 17	10·366379	10·036865	3 3	9·963135	54	30
17	8	9·596903	4 20	10·403097	9·633795	4 23	10·366205	10·036892	4 4	9·963108	52	43
30	10	9·597050	5 24	10·402950	9·633969	5 29	10·366031	10·036919	5 5	9·963081	50	30
18	12	9·597196	6 29	10·402804	9·634143	6 35	10·365857	10·036946	6 5	9·963054	48	42
30	14	9·597343	7 34	10·402657	9·634316	7 40	10·365684	10·036973	7 6	9·963027	46	30
19	16	9·597490	8 39	10·402510	9·634490	8 46	10·365510	10·037001	8 7	9·962999	44	41
30	18	9·597636	9 44	10·402364	9·634664	9 52	10·365336	10·037028	9 8	9·962972	42	30
20	20	9·597783	10 49	10·402217	9·634838	10 58	10·365162	10·037055	10 9	9·962945	40	40
30	22	9·597929	11 54	10·402071	9·635011	11 64	10·364989	10·037082	11 10	9·962918	38	30
21	24	9·598075	12 58	10·401925	9·635185	12 69	10·364815	10·037110	12 11	9·962890	36	39
30	26	9·598222	13 63	10·401778	9·635359	13 75	10·364641	10·037137	13 12	9·962863	34	30
22	28	9·598368	14 68	10·401632	9·635532	14 81	10·364468	10·037164	14 13	9·962836	32	38
30	30	9·598514	15 73	10·401486	9·635706	15 87	10·364294	10·037191	15 14	9·962809	30	30
23	32	9·598660	16 78	10·401340	9·635879	16 92	10·364121	10·037219	16 15	9·962781	28	37
30	34	9·598806	17 83	10·401194	9·636052	17 98	10·363948	10·037246	17 15	9·962754	26	30
24	36	9·598952	18 88	10·401048	9·636226	18 104	10·363774	10·037273	18 16	9·962727	24	36
30	38	9·599098	19 93	10·400902	9·636399	19 110	10·363601	10·037301	19 17	9·962699	22	30
25	40	9·599244	20 98	10·400756	9·636572	20 116	10·363428	10·037328	20 18	9·962672	20	35
30	42	9·599390	21 102	10·400610	9·636745	21 121	10·363255	10·037355	21 19	9·962645	18	30
26	44	9·599536	22 107	10·400464	9·636919	22 127	10·363081	10·037383	22 20	9·962617	16	34
30	46	9·599681	23 112	10·400319	9·637092	23 133	10·362908	10·037410	23 21	9·962590	14	30
27	48	9·599827	24 117	10·400173	9·637265	24 139	10·362735	10·037438	24 22	9·962562	12	33
30	50	9·599973	25 122	10·400027	9·637438	25 144	10·362562	10·037465	25 23	9·962535	10	30
28	52	9·600118	26 127	10·399882	9·637611	26 150	10·362389	10·037492	26 24	9·962508	8	32
30	54	9·600264	27 131	10·399736	9·637783	27 156	10·362217	10·037520	27 25	9·962480	6	30
29	56	9·600409	28 136	10·399591	9·637956	28 162	10·362044	10·037547	28 25	9·962453	4	31
30	58	9·600554	29 141	10·399446	9·638129	29 168	10·361871	10·037575	29 26	9·962425	2	30
30	**34**	9·600700	30 146	10·399300	9·638302	30 173	10·361698	10·037602	30 27	9·962398	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

66° — 4h 26m

LOG. SINES, COSINES, &c.

1h 34m — 23°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
30	0	9·600700		10·399300	9·638302		10·361698	10·037602		9·962398	26	30
30	2	9·600845	1″ 5	10·399155	9·638475	1″ 6	10·361525	10·037630	1″ 1	9·962370	58	30
31	4	9·600990	2 10	10·399010	9·638647	2 11	10·361353	10·037657	2 2	9·962343	56	29
30	6	9·601135	3 14	10·398865	9·638820	3 17	10·361180	10·037685	3 3	9·962315	54	30
32	8	9·601280	4 19	10·398720	9·638992	4 23	10·361008	10·037712	4 4	9·962288	52	28
30	10	9·601425	5 24	10·398575	9·639165	5 29	10·360835	10·037740	5 5	9·962260	50	30
33	12	9·601570	6 29	10·398430	9·639337	6 34	10·360663	10·037767	6 6	9·962233	48	27
30	14	9·601715	7 34	10·398285	9·639510	7 40	10·360490	10·037795	7 6	9·962205	46	30
34	16	9·601860	8 38	10·398140	9·639682	8 46	10·360318	10·037822	8 7	9·962178	44	26
30	18	9·602005	9 43	10·397995	9·639855	9 52	10·360145	10·037850	9 8	9·962150	42	30
35	20	9·602150	10 48	10·397850	9·640027	10 57	10·359973	10·037877	10 9	9·962123	40	25
30	22	9·602294	11 53	10·397706	9·640199	11 63	10·359801	10·037905	11 10	9·962095	38	30
36	24	9·602439	12 58	10·397561	9·640371	12 69	10·359629	10·037933	12 11	9·962067	36	24
30	26	9·602583	13 62	10·397417	9·640544	13 74	10·359456	10·037960	13 12	9·962040	34	30
37	28	9·602728	14 67	10·397272	9·640716	14 80	10·359284	10·037988	14 13	9·962012	32	23
30	30	9·602872	15 72	10·397128	9·640888	15 86	10·359112	10·038015	15 14	9·961985	30	30
38	32	9·603017	16 77	10·396983	9·641060	16 92	10·358940	10·038043	16 15	9·961957	28	22
30	34	9·603161	17 82	10·396839	9·641232	17 97	10·358768	10·038071	17 16	9·961929	26	30
39	36	9·603305	18 87	10·396695	9·641404	18 103	10·358596	10·038098	18 17	9·961902	24	21
30	38	9·603449	19 92	10·396551	9·641575	19 109	10·358425	10·038126	19 17	9·961874	22	30
40	40	9·603594	20 96	10·396406	9·641747	20 115	10·358253	10·038154	20 18	9·961846	20	20
30	42	9·603738	21 101	10·396262	9·641919	21 120	10·358081	10·038181	21 19	9·961819	18	30
41	44	9·603882	22 106	10·396118	9·642091	22 126	10·357909	10·038209	22 20	9·961791	16	19
30	46	9·604026	23 111	10·395974	9·642263	23 132	10·357737	10·038237	23 21	9·961763	14	30
42	48	9·604170	24 115	10·395830	9·642434	24 138	10·357566	10·038265	24 22	9·961735	12	18
30	50	9·604313	25 120	10·395687	9·642606	25 143	10·357394	10·038292	25 23	9·961708	10	30
43	52	9·604457	26 125	10·395543	9·642777	26 149	10·357223	10·038320	26 24	9·961680	8	17
30	54	9·604601	27 130	10·395399	9·642949	27 155	10·357051	10·038348	27 25	9·961652	6	30
44	56	9·604745	28 134	10·395255	9·643120	28 160	10·356880	10·038376	28 26	9·961624	4	16
30	58	9·604888	29 139	10·395112	9·643292	29 166	10·356708	10·038403	29 27	9·961597	2	30
45	35	9·605032	30 144	10·394968	9·643463	30 172	10·356537	10·038431	30 28	9·961569	25	15
30	2	9·605176	1 5	10·394824	9·643634	1 6	10·356366	10·038459	1 1	9·961541	58	30
46	4	9·605319	2 10	10·394681	9·643806	2 11	10·356194	10·038487	2 2	9·961513	56	14
30	6	9·605462	3 14	10·394538	9·643977	3 17	10·356023	10·038515	3 3	9·961485	54	30
47	8	9·605606	4 19	10·394394	9·644148	4 23	10·355852	10·038542	4 4	9·961458	52	13
30	10	9·605749	5 24	10·394251	9·644319	5 28	10·355681	10·038570	5 5	9·961430	50	30
48	12	9·605892	6 29	10·394108	9·644490	6 34	10·355510	10·038598	6 6	9·961402	48	12
30	14	9·606035	7 33	10·393965	9·644661	7 40	10·355339	10·038626	7 7	9·961374	46	30
49	16	9·606179	8 38	10·393821	9·644832	8 46	10·355168	10·038654	8 7	9·961346	44	11
30	18	9·606322	9 43	10·393678	9·645003	9 51	10·354997	10·038682	9 8	9·961318	42	30
50	20	9·606465	10 48	10·393535	9·645174	10 57	10·354826	10·038710	10 9	9·961290	40	10
30	22	9·606608	11 52	10·393392	9·645345	11 63	10·354655	10·038737	11 10	9·961263	38	30
51	24	9·606751	12 57	10·393249	9·645516	12 68	10·354484	10·038765	12 11	9·961235	36	9
30	26	9·606893	13 62	10·393107	9·645687	13 74	10·354313	10·038793	13 12	9·961207	34	30
52	28	9·607036	14 67	10·392964	9·645857	14 80	10·354143	10·038821	14 13	9·961179	32	8
30	30	9·607179	15 71	10·392821	9·646028	15 85	10·353972	10·038849	15 14	9·961151	30	30
53	32	9·607322	16 76	10·392678	9·646199	16 91	10·353801	10·038877	16 15	9·961123	28	7
30	34	9·607464	17 81	10·392536	9·646369	17 97	10·353631	10·038905	17 16	9·961095	26	30
54	36	9·607607	18 86	10·392393	9·646540	18 102	10·353460	10·038933	18 17	9·961067	24	6
30	38	9·607749	19 90	10·392251	9·646710	19 108	10·353290	10·038961	19 18	9·961039	22	30
55	40	9·607892	20 95	10·392108	9·646881	20 114	10·353119	10·038989	20 19	9·961011	20	5
30	42	9·608034	21 100	10·391966	9·647051	21 119	10·352949	10·039017	21 20	9·960983	18	30
56	44	9·608177	22 105	10·391823	9·647222	22 125	10·352778	10·039045	22 20	9·960955	16	4
30	46	9·608319	23 110	10·391681	9·647392	23 131	10·352608	10·039073	23 21	9·960927	14	30
57	48	9·608461	24 114	10·391539	9·647562	24 137	10·352438	10·039101	24 22	9·960899	12	3
30	50	9·608603	25 119	10·391397	9·647733	25 142	10·352267	10·039129	25 23	9·960871	10	30
58	52	9·608745	26 124	10·391255	9·647903	26 148	10·352097	10·039157	26 24	9·960843	8	2
30	54	9·608887	27 128	10·391113	9·648073	27 154	10·351927	10·039186	27 25	9·960814	6	30
59	56	9·609029	28 133	10·390971	9·648243	28 159	10·351757	10·039214	28 26	9·960786	4	1
30	58	9·609171	29 138	10·390829	9·648413	29 165	10·351587	10·039242	29 27	9·960758	2	30
60	36	9·609313	30 143	10·390687	9·648583	30 171	10·351417	10·039270	30 28	9·960730	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

66° — 4h 24m

LOG. SINES, COSINES, &c.

1ʰ 36ᵐ — 24°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·609313		10·390687	9·648583		10·351417	10·039270		9·960730	**24**	60
30	2	9·609455	1″ 5	10·390545	9·648753	1″ 6	10·351247	10·039298	1″ 1	9·960702	58	30
1	4	9·609597	2 9	10·390403	9·648923	2 11	10·351077	10·039326	2 2	9·960674	56	59
30	6	9·609739	3 14	10·390261	9·649093	3 17	10·350907	10·039354	3 3	9·960646	54	30
2	8	9·609880	4 19	10·390120	9·649263	4 23	10·350737	10·039382	4 4	9·960618	52	58
30	10	9·610022	5 23	10·389978	9·649433	5 28	10·350567	10·039411	5 5	9·960589	50	30
3	12	9·610164	6 28	10·389836	9·649602	6 34	10·350398	10·039439	6 6	9·960561	48	57
30	14	9·610305	7 33	10·389695	9·649772	7 39	10·350228	10·039467	7 7	9·960533	46	30
4	16	9·610447	8 38	10·389553	9·649942	8 45	10·350058	10·039495	8 8	9·960505	44	56
30	18	9·610588	9 42	10·389412	9·650111	9 51	10·349889	10·039523	9 8	9·960477	42	30
5	20	9·610729	10 47	10·389271	9·650281	10 56	10·349719	10·039552	10 9	9·960448	40	55
30	22	9·610871	11 52	10·389129	9·650450	11 62	10·349550	10·039580	11 10	9·960420	38	30
6	24	9·611012	12 56	10·388988	9·650620	12 68	10·349380	10·039608	12 11	9·960392	36	54
30	26	9·611153	13 61	10·388847	9·650789	13 73	10·349211	10·039636	13 12	9·960364	34	30
7	28	9·611294	14 66	10·388706	9·650959	14 79	10·349041	10·039665	14 13	9·960335	32	53
30	30	9·611435	15 71	10·388565	9·651128	15 85	10·348872	10·039693	15 14	9·960307	30	30
8	32	9·611576	16 75	10·388424	9·651297	16 90	10·348703	10·039721	16 15	9·960279	28	52
30	34	9·611717	17 80	10·388283	9·651467	17 96	10·348533	10·039750	17 16	9·960250	26	30
9	36	9·611858	18 85	10·388142	9·651636	18 102	10·348364	10·039778	18 17	9·960222	24	51
30	38	9·611999	19 89	10·388001	9·651805	19 107	10·348195	10·039806	19 18	9·960194	22	30
10	40	9·612140	20 94	10·387860	9·651974	20 113	10·348026	10·039835	20 19	9·960165	20	50
30	42	9·612280	21 99	10·387720	9·652143	21 118	10·347857	10·039863	21 20	9·960137	18	30
11	44	9·612421	22 103	10·387579	9·652312	22 124	10·347688	10·039891	22 21	9·960109	16	49
30	46	9·612562	23 108	10·387438	9·652481	23 130	10·347519	10·039920	23 22	9·960080	14	30
12	48	9·612702	24 113	10·387298	9·652650	24 135	10·347350	10·039948	24 23	9·960052	12	48
30	50	9·612843	25 117	10·387157	9·652819	25 141	10·347181	10·039976	25 23	9·960024	10	30
13	52	9·612983	26 122	10·387017	9·652988	26 147	10·347012	10·040005	26 24	9·959995	8	47
30	54	9·613124	27 127	10·386876	9·653157	27 152	10·346843	10·040033	27 25	9·959967	6	30
14	56	9·613264	28 132	10·386736	9·653326	28 158	10·346674	10·040062	28 26	9·959938	4	46
30	58	9·613404	29 136	10·386596	9·653494	29 164	10·346506	10·040090	29 27	9·959910	2	30
15	**37**	9·613545	30 141	10·386455	9·653663	30 169	10·346337	10·040118	30 28	9·959882	**23**	45
30	2	9·613685	1 5	10·386315	9·653832	1 6	10·346168	10·040147	1 1	9·959853	58	30
16	4	9·613825	2 9	10·386175	9·654000	2 11	10·346000	10·040175	2 2	9·959825	56	44
30	6	9·613965	3 14	10·386035	9·654169	3 17	10·345831	10·040204	3 3	9·959796	54	30
17	8	9·614105	4 19	10·385895	9·654337	4 22	10·345663	10·040232	4 4	9·959768	52	43
30	10	9·614245	5 23	10·385755	9·654506	5 28	10·345494	10·040261	5 5	9·959739	50	30
18	12	9·614385	6 28	10·385615	9·654674	6 34	10·345326	10·040289	6 6	9·959711	48	42
30	14	9·614525	7 32	10·385475	9·654843	7 39	10·345157	10·040318	7 7	9·959682	46	30
19	16	9·614665	8 37	10·385335	9·655011	8 45	10·344989	10·040346	8 8	9·959654	44	41
30	18	9·614804	9 42	10·385196	9·655179	9 50	10·344821	10·040375	9 9	9·959625	42	30
20	20	9·614944	10 46	10·385056	9·655348	10 56	10·344652	10·040404	10 10	9·959596	40	40
30	22	9·615084	11 51	10·384916	9·655516	11 62	10·344484	10·040432	11 10	9·959568	38	30
21	24	9·615223	12 56	10·384777	9·655684	12 67	10·344316	10·040461	12 11	9·959539	36	39
30	26	9·615363	13 61	10·384637	9·655852	13 73	10·344148	10·040489	13 12	9·959511	34	30
22	28	9·615502	14 65	10·384498	9·656020	14 78	10·343980	10·040518	14 13	9·959482	32	38
30	30	9·615642	15 70	10·384358	9·656188	15 84	10·343812	10·040547	15 14	9·959453	30	30
23	32	9·615781	16 75	10·384219	9·656356	16 90	10·343644	10·040575	16 15	9·959425	28	37
30	34	9·615921	17 79	10·384079	9·656524	17 95	10·343476	10·040604	17 16	9·959396	26	30
24	36	9·616060	18 84	10·383940	9·656692	18 101	10·343308	10·040632	18 17	9·959368	24	36
30	38	9·616199	19 89	10·383801	9·656860	19 106	10·343140	10·040661	19 18	9·959339	22	30
25	40	9·616338	20 93	10·383662	9·657028	20 112	10·342972	10·040690	20 19	9·959310	20	35
30	42	9·616477	21 98	10·383523	9·657196	21 118	10·342804	10·040718	21 20	9·959282	18	30
26	44	9·616616	22 103	10·383384	9·657364	22 123	10·342636	10·040747	22 21	9·959253	16	34
30	46	9·616755	23 107	10·383245	9·657531	23 129	10·342469	10·040776	23 22	9·959224	14	30
27	48	9·616894	24 112	10·383106	9·657699	24 134	10·342301	10·040805	24 23	9·959195	12	33
30	50	9·517033	25 117	10·382967	9·657867	25 140	10·342133	10·040833	25 24	9·959167	10	30
28	52	9·617172	26 122	10·382828	9·658034	26 146	10·341966	10·040862	26 25	9·959138	8	32
30	54	9·617311	27 126	10·382689	9·658202	27 151	10·341798	10·040891	27 26	9·959109	6	30
29	56	9·617450	28 131	10·382550	9·658369	28 157	10·341631	10·040920	28 27	9·959080	4	31
30	58	9·617588	29 135	10·382412	9·658537	29 162	10·341463	10·040948	29 28	9·959052	2	30
30	**38**	9·617727	30 140	10·382273	9·658704	30 168	10·341296	10·040977	30 29	9·959023	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

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1ʰ 38ᵐ 24°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
30	0	9·617727		10·382273	9·658704		10·341296	10·040977		9·959023	**22**	30
30	2	9·617866	1″ 5	10·382134	9·658871	1″ 6	10·341129	10·041006	1″ 1	9·958994	58	30
31	4	9·618004	2 9	10·381996	9·659039	2 11	10·340961	10·041035	2 2	9·958965	56	29
30	6	9·618143	3 14	10·381857	9·659206	3 17	10·340794	10·041063	3 3	9·958937	54	30
32	8	9·618281	4 18	10·381719	9·659373	4 22	10·340627	10·041092	4 4	9·958908	52	28
30	10	9·618419	5 23	10·381581	9·659540	5 28	10·340460	10·041121	5 5	9·958879	50	30
33	12	9·618558	6 28	10·381442	9·659708	6 33	10·340292	10·041150	6 6	9·958850	48	27
30	14	9·618696	7 32	10·381304	9·659875	7 39	10·340125	10·041179	7 7	9·958821	46	30
34	16	9·618834	8 37	10·381166	9·660042	8 44	10·339958	10·041208	8 8	9·958792	44	26
30	18	9·618972	9 41	10·381028	9·660209	9 50	10·339791	10·041237	9 9	9·958763	42	30
35	20	9·619110	10 46	10·380890	9·660376	10 56	10·339624	10·041266	10 10	9·958734	40	25
30	22	9·619248	11 50	10·380752	9·660543	11 61	10·339457	10·041294	11 11	9·958706	38	30
36	24	9·619386	12 55	10·380614	9·660710	12 67	10·339290	10·041323	12 12	9·958677	36	24
30	26	9·619524	13 59	10·380476	9·660877	13 72	10·339123	10·041352	13 12	9·958648	34	30
37	28	9·619662	14 64	10·380338	9·661043	14 78	10·338957	10·041381	14 13	9·958619	32	23
30	30	9·619800	15 69	10·380200	9·661210	15 83	10·338790	10·041410	15 14	9·958590	30	30
38	32	9·619938	16 73	10·380062	9·661377	16 89	10·338623	10·041439	16 15	9·958561	28	22
30	34	9·620076	17 78	10·379924	9·661544	17 95	10·338456	10·041468	17 16	9·958532	26	30
39	36	9·620213	18 83	10·379787	9·661710	18 100	10·338290	10·041497	18 17	9·958503	24	21
30	38	9·620351	19 87	10·379649	9·661877	19 106	10·338123	10·041526	19 18	9·958474	22	30
40	40	9·620488	20 92	10·379512	9·662043	20 111	10·337957	10·041555	20 19	9·958445	20	20
30	42	9·620626	21 96	10·379374	9·662210	21 117	10·337790	10·041584	21 20	9·958416	18	30
41	44	9·620763	22 101	10·379237	9·662376	22 122	10·337624	10·041613	22 21	9·958387	16	19
30	46	9·620901	23 105	10·379099	9·662543	23 128	10·337457	10·041642	23 22	9·958358	14	30
42	48	9·621038	24 110	10·378962	9·662709	24 133	10·337291	10·041671	24 23	9·958329	12	18
30	50	9·621175	25 114	10·378825	9·662876	25 139	10·337124	10·041700	25 24	9·958300	10	30
43	52	9·621313	26 119	10·378687	9·663042	26 145	10·336958	10·041729	26 25	9·958271	8	17
30	54	9·621450	27 124	10·378550	9·663208	27 150	10·336792	10·041758	27 26	9·958242	6	30
44	56	9·621587	28 129	10·378413	9·663375	28 156	10·336625	10·041787	28 27	9·958213	4	16
30	58	9·621724	29 133	10·378276	9·663541	29 161	10·336459	10·041817	29 28	9·958183	2	30
45	**39**	9·621861	30 138	10·378139	9·663707	30 167	10·336293	10·041846	30 29	9·958154	**21**	15
30	2	9·621998	1 5	10·378002	9·663873	1 6	10·336127	10·041875	1 1	9·958125	58	30
46	4	9·622135	2 9	10·377865	9·664039	2 11	10·335961	10·041904	2 2	9·958096	56	14
30	6	9·622272	3 14	10·377728	9·664205	3 17	10·335795	10·041933	3 3	9·958067	54	30
47	8	9·622409	4 18	10·377591	9·664371	4 22	10·335629	10·041962	4 4	9·958038	52	13
30	10	9·622546	5 23	10·377454	9·664537	5 28	10·335463	10·041991	5 5	9·958009	50	30
48	12	9·622682	6 27	10·377318	9·664703	6 33	10·335297	10·042021	6 6	9·957979	48	12
30	14	9·622819	7 32	10·377181	9·664869	7 39	10·335131	10·042050	7 7	9·957950	46	30
49	16	9·622956	8 36	10·377044	9·665035	8 44	10·334965	10·042079	8 8	9·957921	44	11
30	18	9·623092	9 41	10·376908	9·665200	9 50	10·334800	10·042108	9 9	9·957892	42	30
50	20	9·623229	10 45	10·376771	9·665366	10 55	10·334634	10·042137	10 10	9·957863	40	10
30	22	9·623365	11 50	10·376635	9·665532	11 61	10·334468	10·042167	11 11	9·957833	38	30
51	24	9·623502	12 54	10·376498	9·665698	12 66	10·334302	10·042196	12 12	9·957804	36	9
30	26	9·623638	13 59	10·376362	9·665863	13 72	10·334137	10·042225	13 13	9·957775	34	30
52	28	9·623774	14 63	10·376226	9·666029	14 77	10·333971	10·042254	14 14	9·957746	32	8
30	30	9·623911	15 68	10·376089	9·666194	15 83	10·333806	10·042284	15 15	9·957716	30	30
53	32	9·624047	16 72	10·375953	9·666360	16 88	10·333640	10·042313	16 16	9·957687	28	7
30	34	9·624183	17 77	10·375817	9·666525	17 94	10·333475	10·042342	17 17	9·957658	26	30
54	36	9·624319	18 82	10·375681	9·666691	18 99	10·333309	10·042372	18 18	9·957628	24	6
30	38	9·624455	19 86	10·375545	9·666856	19 105	10·333144	10·042401	19 19	9·957599	22	30
55	40	9·624591	20 91	10·375409	9·667021	20 110	10·332979	10·042430	20 20	9·957570	20	5
30	42	9·624727	21 95	10·375273	9·667187	21 116	10·332813	10·042460	21 20	9·957540	18	30
56	44	9·624863	22 100	10·375137	9·667352	22 121	10·332648	10·042489	22 21	9·957511	16	4
30	46	9·624999	23 104	10·375001	9·667517	23 127	10·332483	10·042518	23 22	9·957482	14	30
57	48	9·625135	24 109	10·374865	9·667682	24 132	10·332318	10·042548	24 23	9·957452	12	3
30	50	9·625270	25 113	10·374730	9·667847	25 138	10·332153	10·042577	25 24	9·957423	10	30
58	52	9·625406	26 118	10·374594	9·668013	26 144	10·331987	10·042607	26 25	9·957393	8	2
30	54	9·625542	27 123	10·374458	9·668178	27 149	10·331822	10·042636	27 26	9·957364	6	30
59	56	9·625677	28 127	10·374323	9·668343	28 155	10·331657	10·042665	28 27	9·957335	1	1
30	58	9·625813	29 132	10·374187	9·668508	29 160	10·331492	10·042695	29 28	9·957305	2	30
60	**40**	9·625948	30 136	10·374052	9·668672	30 166	10·331327	10·042724	30 29	9·957276	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

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′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
0	0	9·625948		10·374052	9·668673		10·331327	10·042724		9·957276	**20**	60
30	2	9·626084	1″ 4	10·373916	9·668837	1″ 5	10·331163	10·042754	1″ 1	9·957246	58	30
1	4	9·626219	2 9	10·373781	9·669002	2 11	10·330998	10·042783	2 2	9·957217	56	59
30	6	9·626354	3 13	10·373646	9·669167	3 16	10·330833	10·042813	3 3	9·957187	54	30
2	8	9·626490	4 18	10·373510	9·669332	4 22	10·330668	10·042842	4 4	9·957158	52	58
30	10	9·626625	5 22	10·373375	9·669497	5 27	10·330503	10·042872	5 5	9·957128	50	30
3	12	9·626760	6 27	10·373240	9·669661	6 33	10·330339	10·042901	6 6	9·957099	48	57
30	14	9·626895	7 31	10·373105	9·669826	7 38	10·330174	10·042931	7 7	9·957069	46	30
4	16	9·627030	8 36	10·372970	9·669991	8 44	10·330009	10·042960	8 8	9·957040	44	56
30	18	9·627165	9 40	10·372835	9·670155	9 49	10·329845	10·042990	9 9	9·957010	42	30
5	20	9·627300	10 45	10·372700	9·670320	10 55	10·329680	10·043019	10 10	9·956981	40	55
30	22	9·627435	11 49	10·372565	9·670484	11 60	10·329516	10·043049	11 11	9·956951	38	30
6	24	9·627570	12 54	10·372430	9·670649	12 66	10·329351	10·043079	12 12	9·956921	36	54
30	26	9·627705	13 58	10·372295	9·670813	13 71	10·329187	10·043108	13 13	9·956892	34	30
7	28	9·627840	14 63	10·372160	9·670977	14 77	10·329023	10·043138	14 14	9·956862	32	53
30	30	9·627974	15 67	10·372026	9·671142	15 82	10·328858	10·043167	15 15	9·956833	30	30
8	32	9·628109	16 72	10·371891	9·671306	16 88	10·328694	10·043197	16 16	9·956803	28	52
30	34	9·628244	17 76	10·371756	9·671470	17 93	10·328530	10·043227	17 17	9·956773	26	30
9	36	9·628378	18 81	10·371622	9·671635	18 99	10·328365	10·043256	18 18	9·956744	24	51
30	38	9·628513	19 85	10·371487	9·671799	19 104	10·328201	10·043286	19 19	9·956714	22	30
10	40	9·628647	20 90	10·371353	9·671963	20 110	10·328037	10·043316	20 20	9·956684	20	50
30	42	9·628782	21 94	10·371218	9·672127	21 115	10·327873	10·043345	21 21	9·956655	18	30
11	44	9·628916	22 99	10·371084	9·672291	22 121	10·327709	10·043375	22 22	9·956625	16	49
30	46	9·629050	23 103	10·370950	9·672455	23 126	10·327545	10·043405	23 23	9·956595	14	30
12	48	9·629185	24 108	10·370815	9·672619	24 132	10·327381	10·043434	24 24	9·956566	12	48
30	50	9·629319	25 112	10·370681	9·672783	25 137	10·327217	10·043464	25 25	9·956536	10	30
13	52	9·629453	26 117	10·370547	9·672947	26 142	10·327053	10·043494	26 26	9·956506	8	47
30	54	9·629587	27 121	10·370413	9·673111	27 148	10·326889	10·043524	27 27	9·956476	6	30
14	56	9·629721	28 126	10·370279	9·673274	28 153	10·326726	10·043553	28 28	9·956447	4	46
30	58	9·629855	29 130	10·370145	9·673438	29 159	10·326562	10·043583	29 29	9·956417	2	30
15	**41**	9·629989	30 135	10·370011	9·673602	30 164	10·326398	10·043613	30 30	9·956387	**19**	45
30	2	9·630123	1 4	10·369877	9·673766	1 5	10·326234	10·043643	1 1	9·956357	58	30
16	4	9·630257	2 9	10·369743	9·673929	2 11	10·326071	10·043673	2 2	9·956327	56	44
30	6	9·630391	3 13	10·369609	9·674093	3 16	10·325907	10·043702	3 3	9·956298	54	30
17	8	9·630524	4 18	10·369476	9·674257	4 22	10·325743	10·043732	4 4	9·956268	52	43
30	10	9·630658	5 22	10·369342	9·674420	5 27	10·325580	10·043762	5 5	9·956238	50	30
18	12	9·630792	6 27	10·369208	9·674584	6 33	10·325416	10·043792	6 6	9·956208	48	42
30	14	9·630925	7 31	10·369075	9·674747	7 38	10·325253	10·043822	7 7	9·956178	46	30
19	16	9·631059	8 36	10·368941	9·674911	8 44	10·325089	10·043852	8 8	9·956148	44	41
30	18	9·631192	9 40	10·368808	9·675074	9 49	10·324926	10·043882	9 9	9·956118	42	30
20	20	9·631326	10 44	10·368674	9·675237	10 54	10·324763	10·043911	10 10	9·956089	40	40
30	22	9·631459	11 49	10·368541	9·675401	11 60	10·324599	10·043941	11 11	9·956059	38	30
21	24	9·631593	12 53	10·368407	9·675564	12 65	10·324436	10·043971	12 12	9·956029	36	39
30	26	9·631726	13 58	10·368274	9·675727	13 71	10·324273	10·044001	13 13	9·955999	34	30
22	28	9·631859	14 62	10·368141	9·675890	14 76	10·324110	10·044031	14 14	9·955969	32	38
30	30	9·631992	15 67	10·368008	9·676053	15 82	10·323947	10·044061	15 15	9·955939	30	30
23	32	9·632125	16 71	10·367875	9·676217	16 87	10·323783	10·044091	16 16	9·955909	28	37
30	34	9·632259	17 75	10·367741	9·676380	17 92	10·323620	10·044121	17 17	9·955879	26	30
24	36	9·632392	18 80	10·367608	9·676543	18 98	10·323457	10·044151	18 18	9·955849	24	36
30	38	9·632525	19 84	10·367475	9·676706	19 103	10·323294	10·044181	19 19	9·955819	22	30
25	40	9·632658	20 89	10·367342	9·676869	20 109	10·323131	10·044211	20 20	9·955789	20	35
30	42	9·632790	21 93	10·367208	9·677032	21 114	10·322968	10·044241	21 21	9·955759	18	30
26	44	9·632923	22 98	10·367077	9·677194	22 120	10·322806	10·044271	22 22	9·955729	16	34
30	46	9·633056	23 102	10·366944	9·677357	23 125	10·322643	10·044301	23 23	9·955699	14	30
27	48	9·633189	24 107	10·366811	9·677520	24 131	10·322480	10·044331	24 24	9·955669	12	33
30	50	9·633322	25 111	10·366678	9·677683	25 136	10·322317	10·044361	25 25	9·955639	10	30
28	52	9·633454	26 116	10·366546	9·677846	26 141	10·322154	10·044391	26 26	9·955609	8	32
30	54	9·633587	27 120	10·366413	9·678008	27 147	10·321992	10·044421	27 27	9·955579	6	30
29	56	9·633719	28 125	10·366281	9·678171	28 152	10·321829	10·044452	28 28	9·955548	4	31
30	58	9·633852	29 129	10·366148	9·678334	29 158	10·321666	10·044482	29 29	9·955518	2	30
30	**42**	9·633984	30 133	10·366016	9·678496	30 163	10·321504	10·044512	30 30	9·955488	0	30
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

64° 4h 18m

LOG. SINES, COSINES, &c.

1h 42m 25°

″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	″
30	0	9·633984		10·366016	9·678496		10·321504	10·044512		9·955488	**18**	30
30	2	9·634117	1″ 4	10·365883	9·678659	1″ 5	10·321341	10·044542	1″ 1	9·955458	58	30
31	4	9·634249	2 9	10·365751	9·678821	2 11	10·321179	10·044572	2 2	9·955428	56	29
30	6	9·634381	3 13	10·365619	9·678984	3 16	10·321016	10·044602	3 3	9·955398	54	30
32	8	9·634514	4 18	10·365486	9·679146	4 22	10·320854	10·044632	4 4	9·955368	52	28
30	10	9·634646	5 22	10·365354	9·679308	5 27	10·320692	10·044663	5 5	9·955337	50	30
33	12	9·634778	6 26	10·365222	9·679471	6 32	10·320529	10·044693	6 6	9·955307	48	27
30	14	9·634910	7 31	10·365090	9·679633	7 38	10·320367	10·044723	7 7	9·955277	46	30
34	16	9·635042	8 35	10·364958	9·679795	8 43	10·320205	10·044753	8 8	9·955247	44	26
30	18	9·635174	9 40	10·364826	9·679958	9 49	10·320042	10·044783	9 9	9·955217	42	30
35	20	9·635306	10 44	10·364694	9·680120	10 54	10·319880	10·044814	10 10	9·955186	40	25
30	22	9·635438	11 48	10·364562	9·680282	11 59	10·319718	10·044844	11 11	9·955156	38	30
36	24	9·635570	12 53	10·364430	9·680444	12 65	10·319556	10·044874	12 12	9·955126	36	24
30	26	9·635702	13 57	10·364298	9·680606	13 70	10·319394	10·044904	13 13	9·955096	34	30
37	28	9·635834	14 61	10·364166	9·680768	14 76	10·319232	10·044935	14 14	9·955065	32	23
30	30	9·635965	15 66	10·364035	9·680930	15 81	10·319070	10·044965	15 15	9·955035	30	30
38	32	9·636097	16 70	10·363903	9·681092	16 86	10·318908	10·044995	16 16	9·955005	28	22
30	34	9·636229	17 75	10·363771	9·681254	17 92	10·318746	10·045026	17 17	9·954974	26	30
39	36	9·636360	18 79	10·363640	9·681416	18 97	10·318584	10·045056	18 18	9·954944	24	21
30	38	9·636492	19 83	10·363508	9·681578	19 103	10·318422	10·045086	19 19	9·954914	22	30
40	40	9·636623	20 88	10·363377	9·681740	20 108	10·318260	10·045117	20 20	9·954883	20	20
30	42	9·636754	21 92	10·363246	9·681901	21 113	10·318099	10·045147	21 21	9·954853	18	30
41	44	9·636886	22 96	10·363114	9·682063	22 119	10·317937	10·045177	22 22	9·954823	16	19
30	46	9·637017	23 101	10·362983	9·682225	23 124	10·317775	10·045208	23 23	9·954792	14	30
42	48	9·637148	24 105	10·362852	9·682387	24 130	10·317613	10·045238	24 24	9·954762	12	18
30	50	9·637280	25 110	10·362720	9·682548	25 135	10·317452	10·045268	25 25	9·954732	10	30
43	52	9·637411	26 114	10·362589	9·682710	26 140	10·317290	10·045299	26 26	9·954701	8	17
30	54	9·637542	27 119	10·362458	9·682871	27 146	10·317129	10·045329	27 27	9·954671	6	30
44	56	9·637673	28 123	10·362327	9·683033	28 151	10·316967	10·045360	28 28	9·954640	4	16
30	58	9·637804	29 127	10·362196	9·683194	29 157	10·316806	10·045390	29 29	9·954610	2	30
45	**43**	9·637935	30 132	10·362065	9·683356	30 162	10·316644	10·045421	30 30	9·954579	**17**	15
30	2	9·638066	1 4	10·361934	9·683517	1 5	10·316483	10·045451	1 1	9·954549	58	30
46	4	9·638197	2 9	10·361803	9·683679	2 11	10·316321	10·045482	2 2	9·954518	56	14
30	6	9·638328	3 13	10·361672	9·683840	3 16	10·316160	10·045512	3 3	9·954488	54	30
47	8	9·638458	4 17	10·361542	9·684001	4 21	10·315999	10·045543	4 4	9·954457	52	13
30	10	9·638589	5 22	10·361411	9·684162	5 27	10·315838	10·045573	5 5	9·954427	50	30
48	12	9·638720	6 26	10·361280	9·684324	6 32	10·315676	10·045604	6 6	9·954396	48	12
30	14	9·638851	7 30	10·361149	9·684485	7 38	10·315515	10·045634	7 7	9·954366	46	30
49	16	9·638981	8 35	10·361019	9·684646	8 43	10·315354	10·045665	8 8	9·954335	44	11
30	18	9·639112	9 39	10·360888	9·684807	9 48	10·315193	10·045695	9 9	9·954305	42	30
50	20	9·639242	10 43	10·360758	9·684968	10 54	10·315032	10·045726	10 10	9·954274	40	10
30	22	9·639373	11 48	10·360627	9·685129	11 59	10·314871	10·045757	11 11	9·954243	38	30
51	24	9·639503	12 52	10·360497	9·685290	12 64	10·314710	10·045787	12 12	9·954213	36	9
30	26	9·639633	13 56	10·360367	9·685451	13 70	10·314549	10·045818	13 13	9·954182	34	30
52	28	9·639764	14 61	10·360236	9·685612	14 75	10·314388	10·045848	14 14	9·954152	32	8
30	30	9·639894	15 65	10·360106	9·685773	15 80	10·314227	10·045879	15 15	9·954121	30	30
53	32	9·640024	16 69	10·359976	9·685934	16 86	10·314066	10·045910	16 16	9·954090	28	7
30	34	9·640154	17 74	10·359846	9·686095	17 91	10·313905	10·045940	17 17	9·954060	26	30
54	36	9·640284	18 78	10·359716	9·686255	18 96	10·313745	10·045971	18 18	9·954029	24	6
30	38	9·640414	19 82	10·359586	9·686416	19 102	10·313584	10·046001	19 19	9·953998	22	30
55	40	9·640544	20 87	10·359456	9·686577	20 107	10·313423	10·046032	20 20	9·953968	20	5
30	42	9·640674	21 91	10·359326	9·686737	21 113	10·313263	10·046063	21 21	9·953937	18	30
56	44	9·640804	22 95	10·359196	9·686898	22 118	10·313102	10·046094	22 22	9·953906	16	4
30	46	9·640934	23 100	10·359066	9·687059	23 123	10·312941	10·046124	23 23	9·953876	14	30
57	48	9·641064	24 104	10·358936	9·687219	24 129	10·312781	10·046155	24 24	9·953845	12	3
30	50	9·641194	25 109	10·358806	9·687380	25 134	10·312620	10·046186	25 25	9·953814	10	30
58	52	9·641324	26 113	10·358676	9·687540	26 139	10·312460	10·046217	26 27	9·953783	8	2
30	54	9·641453	27 117	10·358547	9·687701	27 145	10·312299	10·046247	27 28	9·953753	6	30
59	56	9·641583	28 122	10·358417	9·687861	28 150	10·312139	10·046278	28 29	9·953722	4	1
30	58	9·641712	29 126	10·358288	9·688021	29 155	10·311979	10·046309	29 30	9·953691	2	30
60	**44**	9·641842	30 130	10·358158	9·688182	30 161	10·311818	10·046340	30 31	9·953660	0	0
″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	″

64° 4h 16m

LOG. SINES, COSINES, &c.

1h 44m — 26°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·641842		10·358158	9·688182		10·311818	10·046340		9·953660	16	60
30	2	9·641971	1″ 4	10·358029	9·688342	1″ 5	10·311658	10·046371	1″ 1	9·953629	58	30
1	4	9·642101	2 9	10·357899	9·688502	2 11	10·311498	10·046401	2 2	9·953599	56	59
30	6	9·642230	3 13	10·357770	9·688663	3 16	10·311337	10·046432	3 3	9·953568	54	30
2	8	9·642360	4 17	10·357640	9·688823	4 21	10·311177	10·046463	4 4	9·953537	52	58
30	10	9·642489	5 21	10·357511	9·688983	5 27	10·311017	10·046494	5 5	9·953506	50	30
3	12	9·642618	6 26	10·357382	9·689143	6 32	10·310857	10·046525	6 6	9·953475	48	57
30	14	9·642747	7 30	10·357253	9·689303	7 37	10·310697	10·046556	7 7	9·953444	46	30
4	16	9·642877	8 34	10·357123	9·689463	8 43	10·310537	10·046587	8 8	9·953413	44	56
30	18	9·643006	9 39	10·356994	9·689623	9 48	10·310377	10·046618	9 9	9·953382	42	30
5	20	9·643135	10 43	10·356865	9·689783	10 53	10·310217	10·046648	10 10	9·953352	40	55
30	22	9·643264	11 47	10·356736	9·689943	11 59	10·310057	10·046679	11 11	9·953321	38	30
6	24	9·643393	12 51	10·356607	9·690103	12 64	10·309897	10·046710	12 12	9·953290	36	54
30	26	9·643522	13 56	10·356478	9·690263	13 69	10·309737	10·046741	13 13	9·953259	34	30
7	28	9·643650	14 60	10·356350	9·690423	14 75	10·309577	10·046772	14 14	9·953228	32	53
30	30	9·643779	15 64	10·356221	9·690582	15 80	10·309418	10·046803	15 15	9·953197	30	30
8	32	9·643908	16 68	10·356092	9·690742	16 85	10·309258	10·046834	16 16	9·953166	28	52
30	34	9·644037	17 73	10·355963	9·690902	17 91	10·309098	10·046865	17 18	9·953135	26	30
9	36	9·644165	18 77	10·355835	9·691062	18 96	10·308938	10·046896	18 19	9·953104	24	51
30	38	9·644294	19 82	10·355706	9·691221	19 101	10·308779	10·046927	19 20	9·953073	22	30
10	40	9·644423	20 86	10·355577	9·691381	20 107	10·308619	10·046958	20 21	9·953042	20	50
30	42	9·644551	21 90	10·355449	9·691540	21 112	10·308460	10·046989	21 22	9·953011	18	30
11	44	9·644680	22 94	10·355320	9·691700	22 117	10·308300	10·047020	22 23	9·952980	16	49
30	46	9·644808	23 99	10·355192	9·691859	23 123	10·308141	10·047051	23 24	9·952949	14	30
12	48	9·644936	24 103	10·355064	9·692019	24 128	10·307981	10·047082	24 25	9·952918	12	48
30	50	9·645065	25 107	10·354935	9·692178	25 133	10·307822	10·047114	25 26	9·952886	10	30
13	52	9·645193	26 112	10·354807	9·692338	26 139	10·307662	10·047145	26 27	9·952855	8	47
30	54	9·645321	27 116	10·354679	9·692497	27 144	10·307503	10·047176	27 28	9·952824	6	30
14	56	9·645450	28 120	10·354550	9·692656	28 149	10·307344	10·047207	28 29	9·952793	4	46
30	58	9·645578	29 124	10·354422	9·692816	29 155	10·307184	10·047238	29 30	9·952762	2	30
15	**45**	9·645706	30 129	10·354294	9·692975	30 160	10·307025	10·047269	30 31	9·952731	**15**	45
30	2	9·645834	1 4	10·354166	9·693134	1 5	10·306866	10·047300	1 1	9·952700	58	30
16	4	9·645962	2 9	10·354038	9·693293	2 11	10·306707	10·047331	2 2	9·952669	56	44
30	6	9·646090	3 13	10·353910	9·693453	3 16	10·306547	10·047363	3 3	9·952637	54	30
17	8	9·646218	4 17	10·353782	9·693612	4 21	10·306388	10·047394	4 4	9·952606	52	43
30	10	9·646346	5 21	10·353654	9·693771	5 26	10·306229	10·047425	5 5	9·952575	50	30
18	12	9·646474	6 25	10·353526	9·693930	6 32	10·306070	10·047456	6 6	9·952544	48	42
30	14	9·646601	7 30	10·353399	9·694089	7 37	10·305911	10·047488	7 7	9·952512	46	30
19	16	9·646729	8 34	10·353271	9·694248	8 42	10·305752	10·047519	8 8	9·952481	44	41
30	18	9·646857	9 38	10·353143	9·694407	9 48	10·305593	10·047550	9 9	9·952450	42	30
20	20	9·646984	10 42	10·353016	9·694566	10 53	10·305434	10·047581	10 10	9·952419	40	40
30	22	9·647112	11 47	10·352888	9·694724	11 58	10·305276	10·047613	11 11	9·952387	38	39
21	24	9·647240	12 51	10·352760	9·694883	12 63	10·305117	10·047644	12 13	9·952356	36	39
30	26	9·647367	13 55	10·352633	9·695042	13 69	10·304958	10·047675	13 14	9·952325	34	30
22	28	9·647494	14 59	10·352506	9·695201	14 74	10·304799	10·047706	14 15	9·952294	32	38
30	30	9·647622	15 64	10·352378	9·695360	15 79	10·304640	10·047738	15 16	9·952262	30	30
23	32	9·647749	16 68	10·352251	9·695518	16 85	10·304482	10·047769	16 17	9·952231	28	37
30	34	9·647877	17 72	10·352123	9·695677	17 90	10·304323	10·047800	17 18	9·952200	26	30
24	36	9·648004	18 76	10·351996	9·695836	18 95	10·304164	10·047832	18 19	9·952168	24	36
30	38	9·648131	19 81	10·351869	9·695994	19 101	10·304006	10·047863	19 20	9·952137	22	30
25	40	9·648258	20 85	10·351742	9·696153	20 106	10·303847	10·047894	20 21	9·952106	20	35
30	42	9·648385	21 89	10·351615	9·696311	21 111	10·303689	10·047926	21 22	9·952074	18	30
26	44	9·648512	22 93	10·351488	9·696470	22 116	10·303530	10·047957	22 23	9·952043	16	34
30	46	9·648639	23 98	10·351361	9·696628	23 122	10·303372	10·047989	23 24	9·952011	14	30
27	48	9·648766	24 102	10·351234	9·696787	24 127	10·303213	10·048020	24 25	9·951980	12	33
30	50	9·648893	25 106	10·351107	9·696945	25 132	10·303055	10·048051	25 26	9·951949	10	30
28	52	9·649020	26 110	10·350980	9·697103	26 138	10·302897	10·048083	26 27	9·951917	8	32
30	54	9·649147	27 115	10·350853	9·697262	27 143	10·302739	10·048114	27 28	9·951886	6	30
29	56	9·649274	28 119	10·350726	9·697420	28 148	10·302580	10·048146	28 29	9·951854	4	31
30	58	9·649401	29 123	10·350599	9·697578	29 153	10·302422	10·048177	29 30	9·951823	2	30
30	**46**	9·649527	30 127	10·350473	9·697736	30 159	10·302264	10·048209	30 31	9·951791	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

63° — 4h 14m

LOG. SINES, COSINES, &c.

$1^h\ 46^m$ 26°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
30	0	9·649527		10·350473	9·697736		10·302264	10·048209		9·951791	**14**	30
30	2	9·649654	1″ 4	10·350346	9·697894	1″ 5	10·302106	10·048240	1″ 1	9·951760	58	30
31	4	9·649781	2 8	10·350219	9·698053	2 11	10·301947	10·048272	2 2	9·951728	56	29
30	6	9·649907	3 13	10·350093	9·698211	3 16	10·301789	10·048303	3 3	9·951697	54	30
32	8	9·650034	4 17	10·349966	9·698369	4 21	10·301631	10·048335	4 4	9·951665	52	28
30	10	9·650160	5 21	10·349840	9·698527	5 26	10·301473	10·048366	5 5	9·951634	50	30
33	12	9·650287	6 25	10·349713	9·698685	6 32	10·301315	10·048398	6 6	9·951602	48	27
30	14	9·650413	7 29	10·349587	9·698843	7 37	10·301157	10·048430	7 7	9·951570	46	30
34	16	9·650539	8 34	10·349461	9·699001	8 42	10·300999	10·048461	8 8	9·951539	44	26
30	18	9·650666	9 38	10·349334	9·699159	9 47	10·300841	10·048493	9 9	9·951507	42	30
35	20	9·650792	10 42	10·349208	9·699316	10 53	10·300684	10·048524	10 11	9·951476	40	25
30	22	9·650918	11 46	10·349082	9·699474	11 58	10·300526	10·048556	11 12	9·951444	38	30
36	24	9·651044	12 51	10·348956	9·699632	12 63	10·300368	10·048588	12 13	9·951412	36	24
30	26	9·651171	13 55	10·348829	9·699790	13 68	10·300210	10·048619	13 14	9·951381	34	30
37	28	9·651297	14 59	10·348703	9·699947	14 74	10·300053	10·048651	14 15	9·951349	32	23
30	30	9·651423	15 63	10·348577	9·700105	15 79	10·299895	10·048683	15 16	9·951317	30	30
38	32	9·651549	16 67	10·348451	9·700263	16 84	10·299737	10·048714	16 17	9·951286	28	22
30	34	9·651675	17 71	10·348325	9·700420	17 89	10·299580	10·048746	17 18	9·951254	26	30
39	36	9·651800	18 76	10·348200	9·700578	18 95	10·299422	10·048778	18 19	9·951222	24	21
30	38	9·651926	19 80	10·348074	9·700736	19 100	10·299264	10·048809	19 20	9·951191	22	30
40	40	9·652052	20 84	10·347948	9·700893	20 105	10·299107	10·048841	20 21	9·951159	20	20
30	42	9·652178	21 88	10·347822	9·701051	21 110	10·298949	10·048873	21 22	9·951127	18	30
41	44	9·652304	22 92	10·347696	9·701208	22 116	10·298792	10·048904	22 23	9·951096	16	19
30	46	9·652429	23 97	10·347571	9·701365	23 121	10·298635	10·048936	23 24	9·951064	14	30
42	48	9·652555	24 101	10·347445	9·701523	24 126	10·298477	10·048968	24 25	9·951032	12	18
30	50	9·652680	25 105	10·347320	9·701680	25 131	10·298320	10·049000	25 26	9·951000	10	30
43	52	9·652806	26 109	10·347194	9·701837	26 137	10·298163	10·049032	26 27	9·950968	8	17
30	54	9·652931	27 113	10·347069	9·701995	27 142	10·298005	10·049063	27 28	9·950937	6	30
44	56	9·653057	28 118	10·346943	9·702152	28 147	10·297848	10·049095	28 29	9·950905	4	16
30	58	9·653182	29 122	10·346818	9·702309	29 153	10·297691	10·049127	29 31	9·950873	2	30
45	**47**	9·653308	30 126	10·346692	9·702466	30 158	10·297534	10·049159	30 32	9·950841	**13**	15
30	2	9·653433	1 4	10·346567	9·702623	1 5	10·297377	10·049191	1 1	9·950809	58	30
46	4	9·653558	2 8	10·346442	9·702781	2 10	10·297219	10·049222	2 2	9·950778	56	14
30	6	9·653683	3 12	10·346317	9·702938	3 16	10·297062	10·049254	3 3	9·950746	54	30
47	8	9·653808	4 17	10·346192	9·703095	4 21	10·296905	10·049286	4 4	9·950714	52	13
30	10	9·653934	5 21	10·346066	9·703252	5 26	10·296748	10·049318	5 5	9·950682	50	30
48	12	9·654059	6 25	10·345941	9·703409	6 31	10·296591	10·049350	6 6	9·950650	48	12
30	14	9·654184	7 29	10·345816	9·703566	7 37	10·296434	10·049382	7 7	9·950618	46	30
49	16	9·654309	8 33	10·345691	9·703722	8 42	10·296278	10·049414	8 9	9·950586	44	11
30	18	9·654434	9 37	10·345566	9·703879	9 47	10·296121	10·049446	9 10	9·950554	42	30
50	20	9·654558	10 42	10·345442	9·704036	10 52	10·295964	10·049478	10 11	9·950522	40	10
30	22	9·654683	11 46	10·345317	9·704193	11 57	10·295807	10·049510	11 12	9·950490	38	30
51	24	9·654808	12 50	10·345192	9·704350	12 63	10·295650	10·049542	12 13	9·950458	36	9
30	26	9·654933	13 54	10·345067	9·704506	13 68	10·295494	10·049574	13 14	9·950426	34	30
52	28	9·655058	14 58	10·344942	9·704663	14 73	10·295337	10·049606	14 15	9·950394	32	8
30	30	9·655182	15 62	10·344818	9·704820	15 78	10·295180	10·049638	15 16	9·950362	30	30
53	32	9·655307	16 67	10·344693	9·704976	16 84	10·295024	10·049670	16 17	9·950330	28	7
30	34	9·655431	17 71	10·344569	9·705133	17 89	10·294867	10·049702	17 18	9·950298	26	30
54	36	9·655556	18 75	10·344444	9·705290	18 94	10·294710	10·049734	18 19	9·950266	24	6
30	38	9·655680	19 79	10·344320	9·705446	19 99	10·294554	10·049766	19 20	9·950234	22	30
55	40	9·655805	20 83	10·344195	9·705603	20 104	10·294397	10·049798	20 21	9·950202	20	5
30	42	9·655929	21 87	10·344071	9·705759	21 110	10·294241	10·049830	21 22	9·950170	18	30
56	44	9·656054	22 91	10·343946	9·705916	22 115	10·294084	10·049862	22 23	9·950138	16	4
30	46	9·656178	23 95	10·343822	9·706072	23 120	10·293928	10·049894	23 25	9·950106	14	30
57	48	9·656302	24 100	10·343698	9·706228	24 125	10·293772	10·049926	24 26	9·950074	12	3
30	50	9·656426	25 104	10·343574	9·706385	25 130	10·293615	10·049958	25 27	9·950042	10	30
58	52	9·656551	26 108	10·343449	9·706541	26 136	10·293459	10·049990	26 28	9·950010	8	2
30	54	9·656675	27 112	10·343325	9·706697	27 141	10·293303	10·050023	27 29	9·949977	6	30
59	56	9·656799	28 116	10·343201	9·706854	28 146	10·293146	10·050055	28 30	9·949945	4	1
30	58	9·656923	29 120	10·343077	9·707010	29 151	10·292990	10·050087	29 31	9·949913	2	30
60	**48**	9·657047	30 125	10·342953	9·707166	30 157	10·292834	10·050119	30 32	9·949881	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

63° $4^h\ 12^m$

LOG. SINES, COSINES. &c.

$1^h\ 48^m$ — 27°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·657047		10·342953	9·707166		10·292834	10·050119		9·949881	12	60
30	2	9·657171	1″ 4	10·342829	9·707322	1″ 5	10·292678	10·050151	1″ 1	9·949849	58	30
1	4	9·657295	2 8	10·342705	9·707478	2 10	10·292522	10·050184	2 2	9·949816	56	59
30	6	9·657418	3 12	10·342582	9·707634	3 16	10·292366	10·050216	3 3	9·949784	54	30
2	8	9·657542	4 16	10·342458	9·707790	4 21	10·292210	10·050248	4 4	9·949752	52	58
30	10	9·657666	5 21	10·342334	9·707946	5 26	10·292054	10·050280	5 5	9·949720	50	30
3	12	9·657790	6 25	10·342210	9·708102	6 31	10·291898	10·050312	6 6	9·949688	48	57
30	14	9·657913	7 29	10·342087	9·708258	7 36	10·291742	10·050345	7 8	9·949655	46	30
4	16	9·658037	8 33	10·341963	9·708414	8 42	10·291586	10·050377	8 9	9·949623	44	56
30	18	9·658161	9 37	10·341839	9·708570	9 47	10·291430	10·050409	9 10	9·949591	42	30
5	20	9·658284	10 41	10·341716	9·708726	10 52	10·291274	10·050442	10 11	9·949558	40	55
30	22	9·658408	11 45	10·341592	9·708882	11 57	10·291118	10·050474	11 12	9·949526	38	30
6	24	9·658531	12 49	10·341469	9·709037	12 62	10·290963	10·050506	12 13	9·949494	36	54
30	26	9·658655	13 53	10·341345	9·709193	13 67	10·290807	10·050538	13 14	9·949462	34	30
7	28	9·658778	14 57	10·341222	9·709349	14 73	10·290651	10·050571	14 15	9·949429	32	53
30	30	9·658901	15 62	10·341099	9·709504	15 78	10·290496	10·050603	15 16	9·949397	30	30
8	32	9·659025	16 66	10·340975	9·709660	16 83	10·290340	10·050636	16 17	9·949364	28	52
30	34	9·659148	17 70	10·340852	9·709816	17 88	10·290184	10·050668	17 18	9·949332	26	30
9	36	9·659271	18 74	10·340729	9·709971	18 93	10·290029	10·050700	18 19	9·949300	24	51
30	38	9·659394	19 78	10·340606	9·710127	19 99	10·289873	10·050733	19 21	9·949267	22	30
10	40	9·659517	20 82	10·340483	9·710282	20 104	10·289718	10·050765	20 22	9·949235	20	50
30	42	9·659640	21 86	10·340360	9·710438	21 109	10·289562	10·050798	21 23	9·949202	18	30
11	44	9·659763	22 90	10·340237	9·710593	22 114	10·289407	10·050830	22 24	9·949170	16	49
30	46	9·659886	23 95	10·340114	9·710749	23 119	10·289251	10·050862	23 25	9·949138	14	30
12	48	9·660009	24 99	10·339991	9·710904	24 125	10·289096	10·050895	24 26	9·949105	12	48
30	50	9·660132	25 103	10·339868	9·711059	25 130	10·288941	10·050927	25 27	9·949073	10	30
13	52	9·660255	26 107	10·339745	9·711215	26 135	10·288785	10·050960	26 28	9·949040	8	47
30	54	9·660378	27 111	10·339622	9·711370	27 140	10·288630	10·050992	27 29	9·949008	6	30
14	56	9·660501	28 115	10·339499	9·711525	28 145	10·288475	10·051025	28 30	9·948975	4	46
30	58	9·660623	29 119	10·339377	9·711681	29 151	10·288319	10·051057	29 31	9·948943	2	30
15	**49**	9·660746	30 123	10·339254	9·711836	30 156	10·288164	10·051090	30 32	9·948910	**11**	45
30	2	9·660869	1 4	10·339131	9·711991	1 5	10·288009	10·051122	1 1	9·948878	58	30
16	4	9·660991	2 8	10·339009	9·712146	2 10	10·287854	10·051155	2 2	9·948845	56	44
30	6	9·661114	3 12	10·338886	9·712301	3 15	10·287699	10·051188	3 3	9·948812	54	30
17	8	9·661236	4 16	10·338764	9·712456	4 21	10·287544	10·051220	4 4	9·948780	52	43
30	10	9·661359	5 20	10·338641	9·712611	5 26	10·287389	10·051253	5 5	9·948747	50	30
18	12	9·661481	6 24	10·338519	9·712766	6 31	10·287234	10·051285	6 7	9·948715	48	42
30	14	9·661603	7 28	10·338397	9·712921	7 36	10·287079	10·051318	7 8	9·948682	46	30
19	16	9·661726	8 33	10·338274	9·713076	8 41	10·286924	10·051350	8 9	9·948650	44	41
30	18	9·661848	9 37	10·338152	9·713231	9 46	10·286769	10·051383	9 10	9·948617	42	30
20	20	9·661970	10 41	10·338030	9·713386	10 52	10·286614	10·051416	10 11	9·948584	40	40
30	22	9·662092	11 45	10·337908	9·713541	11 57	10·286459	10·051448	11 12	9·948552	38	30
21	24	9·662214	12 49	10·337786	9·713696	12 62	10·286304	10·051481	12 13	9·948519	36	39
30	26	9·662337	13 53	10·337663	9·713850	13 67	10·286150	10·051514	13 14	9·948486	34	30
22	28	9·662459	14 57	10·337541	9·714005	14 72	10·285995	10·051546	14 15	9·948454	32	38
30	30	9·662581	15 61	10·337419	9·714160	15 77	10·285840	10·051579	15 16	9·948421	30	30
23	32	9·662703	16 65	10·337297	9·714314	16 83	10·285686	10·051612	16 17	9·948388	28	37
30	34	9·662825	17 69	10·337175	9·714469	17 88	10·285531	10·051645	17 18	9·948355	26	30
24	36	9·662946	18 73	10·337054	9·714624	18 93	10·285376	10·051677	18 19	9·948323	24	36
30	38	9·663068	19 77	10·336932	9·714778	19 98	10·285222	10·051710	19 21	9·948290	22	30
25	40	9·663190	20 81	10·336810	9·714933	20 103	10·285067	10·051743	20 22	9·948257	20	35
30	42	9·663312	21 85	10·336688	9·715087	21 108	10·284913	10·051776	21 23	9·948224	18	30
26	44	9·663433	22 89	10·336567	9·715242	22 114	10·284758	10·051808	22 24	9·948192	16	34
30	46	9·663555	23 94	10·336445	9·715396	23 119	10·284604	10·051841	23 25	9·948159	14	30
27	48	9·663677	24 98	10·336323	9·715551	24 124	10·284449	10·051874	24 26	9·948126	12	33
30	50	9·663798	25 102	10·336202	9·715705	25 129	10·284295	10·051907	25 27	9·948093	10	30
28	52	9·663920	26 106	10·336080	9·715860	26 134	10·284140	10·051940	26 28	9·948060	8	32
30	54	9·664041	27 110	10·335959	9·716014	27 139	10·283986	10·051972	27 29	9·948028	6	30
29	56	9·664163	28 114	10·335837	9·716168	28 144	10·283832	10·052005	28 31	9·947995	4	31
30	58	9·664284	29 118	10·335716	9·716322	29 150	10·283678	10·052038	29 32	9·947962	2	30
30	**50**	9·664406	30 122	10·335594	9·716477	30 155	10·283523	10·052071	30 33	9·947929	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

62° — $4^h\ 10^m$

LOG. SINES, COSINES, &c.

1h 50m — 27°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
30	0	9·664406		10·335594	9·716477		10·283523	10·052071		9·947929	**10**	30
30	2	9·664527	1″ 4	10·335473	9·716631	1″ 5	10·283369	10·052104	1″ 1	9·947896	58	30
31	4	9·664648	2 8	10·335352	9·716785	2 10	10·283215	10·052137	2 2	9·947863	56	29
30	6	9·664769	3 12	10·335231	9·716939	3 15	10·283061	10·052170	3 3	9·947830	54	30
32	8	9·664891	4 16	10·335109	9·717093	4 20	10·282907	10·052203	4 4	9·947797	52	28
30	10	9·665012	5 20	10·334988	9·717247	5 26	10·282753	10·052236	5 5	9·947764	50	30
33	12	9·665133	6 24	10·334867	9·717401	6 31	10·282599	10·052269	6 7	9·947731	48	27
30	14	9·665254	7 28	10·334746	9·717555	7 36	10·282445	10·052302	7 8	9·947698	46	30
34	16	9·665375	8 32	10·334625	9·717709	8 41	10·282291	10·052335	8 9	9·947665	44	26
30	18	9·665496	9 36	10·334504	9·717863	9 46	10·282137	10·052367	9 10	9·947633	42	30
35	20	9·665617	10 40	10·334383	9·718017	10 51	10·281983	10·052400	10 11	9·947600	40	25
30	22	9·665738	11 44	10·334262	9·718171	11 56	10·281829	10·052433	11 12	9·947567	38	30
36	24	9·665859	12 48	10·334141	9·718325	12 61	10·281675	10·052467	12 13	9·947533	36	24
30	26	9·665979	13 52	10·334021	9·718479	13 67	10·281521	10·052500	13 14	9·947500	34	30
37	28	9·666100	14 56	10·333900	9·718633	14 72	10·281367	10·052533	14 15	9·947467	32	23
30	30	9·666221	15 60	10·333779	9·718786	15 77	10·281214	10·052566	15 16	9·947434	30	30
38	32	9·666342	16 64	10·333658	9·718940	16 82	10·281060	10·052599	16 18	9·947401	28	22
30	34	9·666462	17 68	10·333538	9·719094	17 87	10·280906	10·052632	17 19	9·947368	26	30
39	36	9·666583	18 72	10·333417	9·719248	18 92	10·280752	10·052665	18 20	9·947335	24	21
30	38	9·666703	19 76	10·333297	9·719401	19 97	10·280599	10·052698	19 21	9·947302	22	30
40	40	9·666824	20 80	10·333176	9·719555	20 102	10·280445	10·052731	20 22	9·947269	20	20
30	42	9·666944	21 84	10·333056	9·719708	21 108	10·280292	10·052764	21 23	9·947236	18	30
41	44	9·667065	22 88	10·332935	9·719862	22 113	10·280138	10·052797	22 24	9·947203	16	19
30	46	9·667185	23 92	10·332815	9·720016	23 118	10·279984	10·052830	23 25	9·947170	14	30
42	48	9·667305	24 96	10·332695	9·720169	24 123	10·279831	10·052864	24 26	9·947136	12	18
30	50	9·667426	25 101	10·332574	9·720322	25 128	10·279678	10·052897	25 28	9·947103	10	30
43	52	9·667546	26 105	10·332454	9·720476	26 133	10·279524	10·052930	26 29	9·947070	8	17
30	54	9·667666	27 109	10·332334	9·720629	27 138	10·279371	10·052963	27 30	9·947037	6	30
44	56	9·667786	28 113	10·332214	9·720783	28 143	10·279217	10·052996	28 31	9·947004	4	16
30	58	9·667906	29 117	10·332094	9·720936	29 148	10·279064	10·053030	29 32	9·946970	2	30
45	**51**	9·668027	30 121	10·331973	9·721089	30 154	10·278911	10·053063	30 33	9·946937	**9**	15
30	2	9·668147	1 4	10·331853	9·721243	1 5	10·278757	10·053096	1 1	9·946904	58	30
46	4	9·668267	2 8	10·331733	9·721396	2 10	10·278604	10·053129	2 2	9·946871	56	14
30	6	9·668386	3 12	10·331614	9·721549	3 15	10·278451	10·053163	3 3	9·946837	54	30
47	8	9·668506	4 16	10·331494	9·721702	4 20	10·278298	10·053196	4 4	9·946804	52	13
30	10	9·668626	5 20	10·331374	9·721855	5 25	10·278145	10·053229	5 6	9·946771	50	30
48	12	9·668746	6 24	10·331254	9·722009	6 30	10·277991	10·053262	6 7	9·946738	48	12
30	14	9·668866	7 28	10·331134	9·722162	7 36	10·277838	10·053296	7 8	9·946704	46	30
49	16	9·668986	8 32	10·331014	9·722315	8 41	10·277685	10·053329	8 9	9·946671	44	11
30	18	9·669105	9 36	10·330895	9·722468	9 46	10·277532	10·053362	9 10	9·946638	42	30
50	20	9·669225	10 40	10·330775	9·722621	10 51	10·277379	10·053396	10 11	9·946604	40	10
30	22	9·669345	11 44	10·330655	9·722774	11 56	10·277226	10·053429	11 12	9·946571	38	30
51	24	9·669464	12 48	10·330536	9·722927	12 61	10·277073	10·053462	12 13	9·946538	36	9
30	26	9·669584	13 52	10·330416	9·723080	13 66	10·276920	10·053496	13 14	9·946504	34	30
52	28	9·669703	14 56	10·330297	9·723232	14 71	10·276768	10·053529	14 16	9·946471	32	8
30	30	9·669823	15 60	10·330177	9·723385	15 76	10·276615	10·053563	15 17	9·946437	30	30
53	32	9·669942	16 64	10·330058	9·723538	16 81	10·276462	10·053596	16 18	9·946404	28	7
30	34	9·670061	17 68	10·329939	9·723691	17 87	10·276309	10·053629	17 19	9·946371	26	30
54	36	9·670181	18 72	10·329819	9·723844	18 92	10·276156	10·053663	18 20	9·946337	24	6
30	38	9·670300	19 76	10·329700	9·723996	19 97	10·276004	10·053696	19 21	9·946304	22	30
55	40	9·670419	20 80	10·329581	9·724149	20 102	10·275851	10·053730	20 22	9·946270	20	5
30	42	9·670538	21 84	10·329462	9·724302	21 107	10·275698	10·053763	21 23	9·946237	18	30
56	44	9·670658	22 88	10·329342	9·724454	22 112	10·275546	10·053797	22 24	9·946203	16	4
30	46	9·670777	23 92	10·329223	9·724607	23 117	10·275393	10·053830	23 26	9·946170	14	30
57	48	9·670896	24 96	10·329104	9·724760	24 122	10·275240	10·053864	24 27	9·946136	12	3
30	50	9·671015	25 100	10·328985	9·724912	25 127	10·275088	10·053897	25 28	9·946103	10	30
58	52	9·671134	26 104	10·328866	9·725065	26 132	10·274935	10·053931	26 29	9·946069	8	2
30	54	9·671253	27 107	10·328747	9·725217	27 137	10·274783	10·053964	27 30	9·946036	6	30
59	56	9·671372	28 111	10·328628	9·725370	28 143	10·274630	10·053998	28 31	9·946002	4	1
30	58	9·671490	29 115	10·328510	9·725522	29 148	10·274478	10·054031	29 32	9·945969	2	30
60	**52**	9·671609	30 119	10·328391	9·725674	30 153	10·274326	10·054065	30 33	9·945935	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

LOG. SINES, COSINES, &c.

1h 52m — 28°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
0	0	9·671609		10·328391	9·725674		10·274326	10·054065		9·945935	8	60
30	2	9·671728	1″ 4	10·328272	9·725827	1″ 5	10·274173	10·054099	1″ 1	9·945901	58	30
1	4	9·671847	2 8	10·328153	9·725979	2 10	10·274021	10·054132	2 2	9·945868	56	59
30	6	9·671965	3 12	10·328035	9·726131	3 15	10·273869	10·054166	3 3	9·945834	54	30
2	8	9·672084	4 16	10·327916	9·726284	4 20	10·273716	10·054200	4 4	9·945800	52	58
30	10	9·672203	5 20	10·327797	9·726436	5 25	10·273564	10·054233	5 6	9·945767	50	30
3	12	9·672321	6 24	10·327679	9·726588	6 30	10·273412	10·054267	6 7	9·945733	48	57
30	14	9·672440	7 28	10·327560	9·726740	7 35	10·273260	10·054300	7 8	9·945700	46	30
4	16	9·672558	8 32	10·327442	9·726892	8 40	10·273108	10·054334	8 9	9·945666	44	56
30	18	9·672677	9 35	10·327323	9·727045	9 46	10·272955	10·054368	9 10	9·945632	42	30
5	20	9·672795	10 39	10·327205	9·727197	10 51	10·272803	10·054402	10 11	9·945598	40	55
30	22	9·672914	11 43	10·327086	9·727349	11 56	10·272651	10·054435	11 12	9·945565	38	30
6	24	9·673032	12 47	10·326968	9·727501	12 61	10·272499	10·054469	12 13	9·945531	36	54
30	26	9·673150	13 51	10·326850	9·727653	13 66	10·272347	10·054503	13 15	9·945497	34	30
7	28	9·673268	14 55	10·326732	9·727805	14 71	10·272195	10·054536	14 16	9·945464	32	53
30	30	9·673387	15 59	10·326613	9·727957	15 76	10·272043	10·054570	15 17	9·945430	30	30
8	32	9·673505	16 63	10·326495	9·728109	16 81	10·271891	10·054604	16 18	9·945396	28	52
30	34	9·673623	17 67	10·326377	9·728261	17 86	10·271739	10·054638	17 19	9·945362	26	30
9	36	9·673741	18 71	10·326259	9·728412	18 91	10·271588	10·054672	18 20	9·945328	24	61
30	38	9·673859	19 75	10·326141	9·728564	19 96	10·271436	10·054705	19 21	9·945295	22	30
10	40	9·673977	20 79	10·326023	9·728716	20 101	10·271284	10·054739	20 23	9·945261	20	50
30	42	9·674095	21 83	10·325905	9·728868	21 106	10·271132	10·054773	21 24	9·945227	18	30
11	44	9·674213	22 87	10·325787	9·729020	22 111	10·270980	10·054807	22 25	9·945193	16	49
30	46	9·674331	23 91	10·325669	9·729171	23 116	10·270829	10·054841	23 26	9·945159	14	30
12	48	9·674448	24 95	10·325552	9·729323	24 121	10·270677	10·054875	24 27	9·945125	12	48
30	50	9·674566	25 99	10·325434	9·729475	25 126	10·270525	10·054908	25 28	9·945092	10	30
13	52	9·674684	26 103	10·325316	9·729626	26 132	10·270374	10·054942	26 29	9·945058	8	47
30	54	9·674802	27 106	10·325198	9·729778	27 137	10·270222	10·054976	27 30	9·945024	6	30
14	56	9·674919	28 110	10·325081	9·729929	28 142	10·270071	10·055010	28 31	9·944990	4	46
30	58	9·675037	29 114	10·324963	9·730081	29 147	10·269919	10·055044	29 32	9·944956	2	30
15	53	9·675155	30 118	10·324845	9·730233	30 152	10·269767	10·055078	30 34	9·944922	7	45
30	2	9·675272	1 4	10·324728	9·730384	1 5	10·269616	10·055112	1 1	9·944888	58	30
16	4	9·675390	2 8	10·324610	9·730535	2 10	10·269465	10·055146	2 2	9·944854	56	44
30	6	9·675507	3 12	10·324493	9·730687	3 15	10·269313	10·055180	3 3	9·944820	54	30
17	8	9·675624	4 16	10·324376	9·730838	4 20	10·269162	10·055214	4 5	9·944786	52	43
30	10	9·675742	5 19	10·324258	9·730990	5 25	10·269010	10·055248	5 6	9·944752	50	30
18	12	9·675859	6 23	10·324141	9·731141	6 30	10·268859	10·055282	6 7	9·944718	48	42
30	14	9·675976	7 27	10·324024	9·731292	7 35	10·268708	10·055316	7 8	9·944684	46	30
19	16	9·676094	8 31	10·323906	9·731444	8 40	10·268556	10·055350	8 9	9·944650	44	41
30	18	9·676211	9 35	10·323789	9·731595	9 45	10·268405	10·055384	9 10	9·944616	42	30
20	20	9·676328	10 39	10·323672	9·731746	10 50	10·268254	10·055418	10 11	9·944582	40	40
30	22	9·676445	11 43	10·323555	9·731897	11 55	10·268103	10·055452	11 12	9·944548	38	30
21	24	9·676562	12 47	10·323438	9·732048	12 60	10·267952	10·055486	12 14	9·944514	36	39
30	26	9·676679	13 51	10·323321	9·732200	13 65	10·267800	10·055520	13 15	9·944480	34	30
22	28	9·676796	14 55	10·323204	9·732351	14 70	10·267649	10·055554	14 16	9·944446	32	38
30	30	9·676913	15 58	10·323087	9·732502	15 75	10·267498	10·055588	15 17	9·944412	30	30
23	32	9·677030	16 62	10·322970	9·732653	16 80	10·267347	10·055623	16 18	9·944377	28	37
30	34	9·677147	17 66	10·322853	9·732804	17 86	10·267196	10·055657	17 19	9·944343	26	30
24	36	9·677264	18 70	10·322736	9·732955	18 91	10·267045	10·055691	18 20	9·944309	24	36
30	38	9·677381	19 74	10·322619	9·733106	19 96	10·266894	10·055725	19 22	9·944275	22	30
25	40	9·677498	20 78	10·322502	9·733257	20 101	10·266743	10·055759	20 23	9·944241	20	35
30	42	9·677614	21 82	10·322386	9·733408	21 106	10·266592	10·055793	21 24	9·944207	18	30
26	44	9·677731	22 86	10·322269	9·733558	22 111	10·266442	10·055828	22 25	9·944172	16	34
30	46	9·677848	23 89	10·322152	9·733709	23 116	10·266291	10·055862	23 26	9·944138	14	30
27	48	9·677964	24 93	10·322036	9·733860	24 121	10·266140	10·055896	24 27	9·944104	12	33
30	50	9·678081	25 97	10·321919	9·734011	25 126	10·265989	10·055930	25 28	9·944070	10	30
28	52	9·678197	26 101	10·321803	9·734162	26 131	10·265838	10·055964	26 29	9·944036	8	32
30	54	9·678314	27 105	10·321686	9·734312	27 136	10·265688	10·055999	27 31	9·944001	6	30
29	56	9·678430	28 109	10·321570	9·734463	28 141	10·265537	10·056033	28 32	9·943967	4	31
30	58	9·678547	29 113	10·321453	9·734614	29 146	10·265386	10·056067	29 33	9·943933	2	30
30	54	9·678663	30 117	10·321337	9·734764	30 151	10·265236	10·056101	30 34	9·943899	0	30
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

61° — 4h 6m

LOG. SINES, COSINES, &c.

1ʰ 54ᵐ — 28°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
30	0	9·678663		10·321337	9·734764		10·265236	10·056101		9·943899	6	30
30	2	9·678779	1″ 4	10·321221	9·734915	1″ 5	10·265085	10·056136	1″ 1	9·943864	58	30
31	4	9·678895	2 8	10·321105	9·735066	2 10	10·264934	10·056170	2 2	9·943830	56	29
30	6	9·679012	3 12	10·320988	9·735216	3 15	10·264784	10·056204	3 3	9·943796	54	30
32	8	9·679128	4 15	10·320872	9·735367	4 20	10·264633	10·056239	4 5	9·943761	52	28
30	10	9·679244	5 19	10·320756	9·735517	5 25	10·264483	10·056273	5 6	9·943727	50	30
33	12	9·679360	6 23	10·320640	9·735668	6 30	10·264332	10·056307	6 7	9·943693	48	27
30	14	9·679476	7 27	10·320524	9·735818	7 35	10·264182	10·056342	7 8	9·943658	46	30
34	16	9·679592	8 31	10·320408	9·735969	8 40	10·264031	10·056376	8 9	9·943624	44	26
30	18	9·679708	9 35	10·320292	9·736119	9 45	10·263881	10·056411	9 10	9·943589	42	30
35	20	9·679824	10 39	10·320176	9·736269	10 50	10·263731	10·056445	10 11	9·943555	40	25
30	22	9·679940	11 42	10·320060	9·736420	11 55	10·263580	10·056479	11 13	9·943521	38	30
36	24	9·680056	12 46	10·319944	9·736570	12 60	10·263430	10·056514	12 14	9·943486	36	24
30	26	9·680172	13 50	10·319828	9·736720	13 65	10·263280	10·056548	13 15	9·943452	34	30
37	28	9·680288	14 54	10·319712	9·736870	14 70	10·263130	10·056583	14 16	9·943417	32	23
30	30	9·680403	15 58	10·319597	9·737021	15 75	10·262979	10·056617	15 17	9·943383	30	30
38	32	9·680519	16 62	10·319481	9·737171	16 80	10·262829	10·056652	16 18	9·943348	28	22
30	34	9·680635	17 66	10·319365	9·737321	17 85	10·262679	10·056686	17 20	9·943314	26	30
39	36	9·680750	18 69	10·319250	9·737471	18 90	10·262529	10·056721	18 21	9·943279	24	21
30	38	9·680866	19 73	10·319134	9·737621	19 95	10·262379	10·056755	19 22	9·943245	22	30
40	40	9·680982	20 77	10·319018	9·737771	20 100	10·262229	10·056790	20 23	9·943210	20	20
30	42	9·681097	21 81	10·318903	9·737921	21 105	10·262079	10·056824	21 24	9·943176	18	30
41	44	9·681213	22 85	10·318787	9·738071	22 110	10·261929	10·056859	22 25	9·943141	16	19
30	46	9·681328	23 89	10·318672	9·738221	23 115	10·261779	10·056893	23 26	9·943107	14	30
42	48	9·681443	24 93	10·318557	9·738371	24 120	10·261629	10·056928	24 28	9·943072	12	18
30	50	9·681559	25 97	10·318441	9·738521	25 125	10·261479	10·056963	25 29	9·943037	10	30
43	52	9·681674	26 100	10·318326	9·738671	26 130	10·261329	10·056997	26 30	9·943003	8	17
30	54	9·681789	27 104	10·318211	9·738821	27 135	10·261179	10·057032	27 31	9·942968	6	30
44	56	9·681905	28 108	10·318095	9·738971	28 140	10·261029	10·057066	28 32	9·942934	4	16
30	58	9·682020	29 112	10·317980	9·739121	29 145	10·260879	10·057101	29 33	9·942899	2	30
45	**55**	9·682135	30 116	10·317865	9·739271	30 150	10·260729	10·057136	30 34	9·942864	**5**	15
30	2	9·682250	1 4	10·317750	9·739420	1 5	10·260580	10·057170	1 1	9·942830	58	30
46	4	9·682365	2 8	10·317635	9·739570	2 10	10·260430	10·057205	2 2	9·942795	56	14
30	6	9·682480	3 11	10·317520	9·739720	3 15	10·260280	10·057240	3 3	9·942760	54	30
47	8	9·682595	4 15	10·317405	9·739870	4 20	10·260130	10·057274	4 5	9·942726	52	13
30	10	9·682710	5 19	10·317290	9·740019	5 25	10·259981	10·057309	5 6	9·942691	50	30
48	12	9·682825	6 23	10·317175	9·740169	6 30	10·259831	10·057344	6 7	9·942656	48	12
30	14	9·682940	7 27	10·317060	9·740319	7 35	10·259681	10·057379	7 8	9·942621	46	30
49	16	9·683055	8 31	10·316945	9·740468	8 40	10·259532	10·057413	8 9	9·942587	44	11
30	18	9·683170	9 34	10·316830	9·740618	9 45	10·259382	10·057448	9 10	9·942552	42	30
50	20	9·683284	10 38	10·316716	9·740767	10 50	10·259233	10·057483	10 11	9·942517	40	10
30	22	9·683399	11 42	10·316601	9·740917	11 55	10·259083	10·057518	11 13	9·942482	38	30
51	24	9·683514	12 46	10·316486	9·741066	12 60	10·258934	10·057552	12 14	9·942448	36	9
30	26	9·683628	13 50	10·316372	9·741216	13 65	10·258784	10·057587	13 15	9·942413	34	30
52	28	9·683743	14 54	10·316257	9·741365	14 70	10·258635	10·057622	14 16	9·942378	32	8
30	30	9·683858	15 57	10·316142	9·741514	15 75	10·258486	10·057657	15 17	9·942343	30	30
53	32	9·683972	16 61	10·316028	9·741664	16 80	10·258336	10·057692	16 19	9·942308	28	7
30	34	9·684087	17 65	10·315913	9·741813	17 85	10·258187	10·057727	17 20	9·942273	26	30
54	36	9·684201	18 69	10·315799	9·741962	18 90	10·258038	10·057761	18 21	9·942239	24	6
30	38	9·684315	19 73	10·315685	9·742112	19 95	10·257888	10·057796	19 22	9·942204	22	30
55	40	9·684430	20 76	10·315570	9·742261	20 100	10·257739	10·057831	20 23	9·942169	20	5
30	42	9·684544	21 80	10·315456	9·742410	21 105	10·257590	10·057866	21 24	9·942134	18	30
56	44	9·684658	22 84	10·315342	9·742559	22 110	10·257441	10·057901	22 26	9·942099	16	4
30	46	9·684773	23 88	10·315227	9·742709	23 115	10·257291	10·057936	23 27	9·942064	14	30
57	48	9·684887	24 92	10·315113	9·742858	24 120	10·257142	10·057971	24 28	9·942029	12	3
30	50	9·685001	25 96	10·314999	9·743007	25 124	10·256993	10·058006	25 29	9·941994	10	30
58	52	9·685115	26 100	10·314885	9·743156	26 129	10·256844	10·058041	26 30	9·941959	8	2
30	54	9·685229	27 103	10·314771	9·743305	27 134	10·256695	10·058076	27 31	9·941924	6	30
59	56	9·685343	28 107	10·314657	9·743454	28 139	10·256546	10·058111	28 32	9·941889	4	1
30	58	9·685457	29 111	10·314543	9·743603	29 144	10·256397	10·058146	29 34	9·941854	2	30
60	**56**	9·685571	30 115	10·314429	9·743752	30 149	10·256248	10·058181	30 35	9·941819	0	0
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

61° — 4ʰ 4ᵐ

LOG. SINES, COSINES, &c.

1h 56m — 29°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·685571		10·314429	9·743752		10·256248	10·058181		9·941819	4	60
30	2	9·685685	1″ 4	10·314315	9·743901	1″ 5	10·256099	10·058216	1″ 1	9·941784	58	30
1	4	9·685799	2 8	10·314201	9·744050	2 10	10·255950	10·058251	2 2	9·941749	56	59
30	6	9·685913	3 11	10·314087	9·744199	3 15	10·255801	10·058286	3 4	9·941714	54	30
2	8	9·686027	4 15	10·313973	9·744348	4 20	10·255652	10·058321	4 5	9·941679	52	58
30	10	9·686141	5 19	10·313859	9·744496	6 25	10·255504	10·058356	5 6	9·941644	50	30
3	12	9·686254	6 23	10·313746	9·744645	6 30	10·255355	10·058391	6 7	9·941609	48	57
30	14	9·686368	7 26	10·313632	9·744794	7 35	10·255206	10·058426	7 8	9·941574	46	30
4	16	9·686482	8 30	10·313518	9·744943	8 40	10·255057	10·058461	8 9	9·941539	44	56
30	18	9·686595	9 34	10·313405	9·745092	9 45	10·254908	10·058496	9 11	9·941504	42	30
5	20	9·686709	10 38	10·313291	9·745240	10 49	10·254760	10·058531	10 12	9·941469	40	55
30	22	9·686822	11 42	10·313178	9·745389	11 54	10·254611	10·058567	11 13	9·941433	38	30
6	24	9·686936	12 46	10·313064	9·745538	12 59	10·254462	10·058602	12 14	9·941398	36	54
30	26	9·687049	13 49	10·312951	9·745686	13 64	10·254314	10·058637	13 15	9·941363	34	30
7	28	9·687163	14 53	10·312837	9·745835	14 69	10·254165	10·058672	14 16	9·941328	32	53
30	30	9·687276	15 57	10·312724	9·745983	15 74	10·254017	10·058707	15 18	9·941293	30	30
8	32	9·687389	16 61	10·312611	9·746132	16 79	10·253868	10·058742	16 19	9·941258	28	52
30	34	9·687503	17 64	10·312497	9·746281	17 84	10·253719	10·058778	17 20	9·941222	26	30
9	36	9·687616	18 68	10·312384	9·746429	18 89	10·253571	10·058813	18 21	9·941187	24	51
30	38	9·687729	19 72	10·312271	9·746577	19 94	10·253423	10·058848	19 22	9·941152	22	30
10	40	9·687843	20 76	10·312157	9·746726	20 99	10·253274	10·058883	20 23	9·941117	20	50
30	42	9·687956	21 79	10·312044	9·746874	21 104	10·253126	10·058919	21 25	9·941081	18	30
11	44	9·688069	22 83	10·311931	9·747023	22 109	10·252977	10·058954	22 26	9·941046	16	49
30	46	9·688182	23 87	10·311818	9·747171	23 114	10·252829	10·058989	23 27	9·941011	14	30
12	48	9·688295	24 91	10·311705	9·747319	24 119	10·252681	10·059025	24 28	9·940975	12	48
30	50	9·688408	25 95	10·311592	9·747468	25 124	10·252532	10·059060	25 29	9·940940	10	30
13	52	9·688521	26 98	10·311479	9·747616	26 129	10·252384	10·059095	26 30	9·940905	8	47
30	54	9·688634	27 102	10·311366	9·747764	27 134	10·252236	10·059130	27 32	9·940870	6	30
14	56	9·688747	28 106	10·311253	9·747913	28 139	10·252087	10·059166	28 33	9·940834	4	46
30	58	9·688860	29 110	10·311140	9·748061	29 144	10·251939	10·059201	29 34	9·940799	2	30
15	**57**	9·688972	30 113	10·311028	9·748209	30 148	10·251791	10·059237	30 35	9·940763	**3**	45
30	2	9·689085	1 4	10·310915	9·748357	1 5	10·251643	10·059272	1 1	9·940728	58	30
16	4	9·689198	2 7	10·310802	9·748505	2 10	10·251495	10·059307	2 2	9·940693	56	44
30	6	9·689311	3 11	10·310689	9·748653	3 15	10·251347	10·059343	3 4	9·940657	54	30
17	8	9·689423	4 15	10·310577	9·748801	4 20	10·251199	10·059378	4 5	9·940622	52	43
30	10	9·689536	5 19	10·310464	9·748949	5 25	10·251051	10·059414	5 6	9·940586	50	30
18	12	9·689648	6 22	10·310352	9·749097	6 30	10·250903	10·059449	6 7	9·940551	48	42
30	14	9·689761	7 26	10·310239	9·749245	7 34	10·250755	10·059484	7 8	9·940516	46	30
19	16	9·689873	8 30	10·310127	9·749393	8 39	10·250607	10·059520	8 9	9·940480	44	41
30	18	9·689986	9 34	10·310014	9·749541	9 44	10·250459	10·059555	9 11	9·940445	42	30
20	20	9·690098	10 37	10·309902	9·749689	10 49	10·250311	10·059591	10 12	9·940409	40	40
30	22	9·690211	11 41	10·309789	9·749837	11 54	10·250163	10·059626	11 13	9·940374	38	30
21	24	9·690323	12 45	10·309677	9·749985	12 59	10·250015	10·059662	12 14	9·940338	36	39
30	26	9·690435	13 49	10·309565	9·750133	13 64	10·249867	10·059697	13 15	9·940303	34	30
22	28	9·690548	14 52	10·309452	9·750281	14 69	10·249719	10·059733	14 17	9·940267	32	38
30	30	9·690660	15 56	10·309340	9·750428	15 74	10·249572	10·059769	15 18	9·940231	30	30
23	32	9·690772	16 60	10·309228	9·750576	16 79	10·249424	10·059804	16 19	9·940196	28	37
30	34	9·690884	17 64	10·309116	9·750724	17 84	10·249276	10·059840	17 20	9·940160	26	30
24	36	9·690996	18 67	10·309004	9·750872	18 89	10·249128	10·059875	18 21	9·940125	24	36
30	38	9·691108	19 71	10·308892	9·751019	19 93	10·248981	10·059911	19 22	9·940089	22	30
25	40	9·691220	20 75	10·308780	9·751167	20 98	10·248833	10·059946	20 24	9·940054	20	35
30	42	9·691332	21 79	10·308668	9·751315	21 103	10·248685	10·059982	21 25	9·940018	18	30
26	11	9·691444	22 82	10·308556	9·751462	22 108	10·248538	10·060018	22 26	9·939982	16	34
30	46	9·691556	23 86	10·308444	9·751610	23 113	10·248390	10·060053	23 27	9·939947	14	30
27	48	9·691668	24 90	10·308332	9·751757	24 118	10·248243	10·060089	24 28	9·939911	12	33
30	50	9·691780	25 94	10·308220	9·751905	25 123	10·248095	10·060125	25 30	9·939875	10	30
28	52	9·691892	26 98	10·308108	9·752052	26 128	10·247948	10·060160	26 31	9·939840	8	32
30	54	9·692004	27 101	10·307996	9·752200	27 133	10·247800	10·060196	27 32	9·939804	6	30
29	56	9·692115	28 105	10·307885	9·752347	28 138	10·247653	10·060232	28 33	9·939768	4	31
30	58	9·692227	29 108	10·307773	9·752495	29 143	10·247505	10·060267	29 34	9·939733	2	30
30	**58**	9·692339	30 112	10·307661	9·752642	30 148	10·247358	10·060303	30 36	9·939697	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

60° — 4h 2m

LOG. SINES, COSINES, &c.

1h 58m 29°

′ ″	m. s	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	″
30	0	9·692339		10·307661	9·752642		10·247358	10·060303		9·939697	2	30
30	2	9·692450	1″ 4	10·307550	9·752789	1″ 5	10·247211	10·060339	1″ 1	9·939661	58	30
31	4	9·692562	2 7	10·307438	9·752937	2 10	10·247063	10·060375	2 2	9·939625	56	29
30	6	9·692674	3 11	10·307326	9·753084	3 15	10·246916	10·060410	3 4	9·939590	54	30
32	8	9·692785	4 15	10·307215	9·753231	4 20	10·246769	10·060446	4 5	9·939554	52	28
30	10	9·692897	5 18	10·307103	9·753379	5 25	10·246621	10·060482	5 6	9·939518	50	30
33	12	9·693008	6 22	10·306992	9·753526	6 29	10·246474	10·060518	6 7	9·939482	48	27
30	14	9·693119	7 26	10·306881	9·753673	7 34	10·246327	10·060554	7 8	9·939446	46	30
34	16	9·693231	8 30	10·306769	9·753820	8 39	10·246180	10·060590	8 10	9·939410	44	26
30	18	9·693342	9 33	10·306658	9·753967	9 44	10·246033	10·060625	9 11	9·939375	42	30
35	20	9·693453	10 37	10·306547	9·754115	10 49	10·245885	10·060661	10 12	9·939339	40	25
30	22	9·693565	11 41	10·306435	9·754262	11 54	10·245738	10·060697	11 13	9·939303	38	30
36	24	9·693676	12 44	10·306324	9·754409	12 59	10·245591	10·060733	12 14	9·939267	36	24
30	26	9·693787	13 48	10·306213	9·754556	13 64	10·245444	10·060769	13 15	9·939231	34	30
37	28	9·693898	14 52	10·306102	9·754703	14 69	10·245297	10·060805	14 17	9·939195	32	23
30	30	9·694009	15 56	10·305991	9·754850	15 73	10·245150	10·060841	15 18	9·939159	30	30
38	32	9·694120	16 59	10·305880	9·754997	16 78	10·245003	10·060877	16 19	9·939123	28	22
30	34	9·694231	17 63	10·305769	9·755144	17 83	10·244856	10·060913	17 20	9·939087	26	30
39	36	9·694342	18 67	10·305658	9·755291	18 88	10·244709	10·060948	18 22	9·939052	24	21
30	38	9·694453	19 70	10·305547	9·755438	19 93	10·244562	10·060984	19 23	9·939016	22	30
40	40	9·694564	20 74	10·305436	9·755585	20 98	10·244415	10·061020	20 24	9·938980	20	20
30	42	9·694675	21 78	10·305325	9·755731	21 103	10·244269	10·061056	21 25	9·938944	18	30
41	44	9·694786	22 81	10·305214	9·755878	22 108	10·244122	10·061092	22 26	9·938908	16	19
30	46	9·694897	23 85	10·305103	9·756025	23 113	10·243975	10·061128	23 28	9·938872	14	30
42	48	9·695007	24 89	10·304993	9·756172	24 118	10·243828	10·061164	24 29	9·938836	12	18
30	50	9·695118	25 93	10·304882	9·756319	25 122	10·243681	10·061200	25 30	9·938800	10	30
43	52	9·695229	26 97	10·304771	9·756465	26 127	10·243535	10·061237	26 31	9·938763	8	17
30	54	9·695339	27 100	10·304661	9·756612	27 132	10·243388	10·061273	27 32	9·938727	6	30
44	56	9·695450	28 104	10·304550	9·756759	28 137	10·243241	10·061309	28 34	9·938691	4	16
30	58	9·695561	29 107	10·304439	9·756905	29 142	10·243095	10·061345	29 35	9·938655	2	30
45	**59**	9·695671	30 111	10·304329	9·757052	30 147	10·242948	10·061381	30 36	9·938619	**1**	15
30	2	9·695782	1 4	10·304218	9·757199	1 5	10·242801	10·061417	1 1	9·938583	58	30
46	4	9·695892	2 7	10·304108	9·757345	2 10	10·242655	10·061453	2 2	9·938547	56	14
30	6	9·696003	3 11	10·303997	9·757492	3 15	10·242508	10·061489	3 4	9·938511	54	30
47	8	9·696113	4 15	10·303887	9·757638	4 19	10·242362	10·061525	4 5	9·938475	52	13
30	10	9·696223	5 18	10·303777	9·757785	5 24	10·242215	10·061561	5 6	9·938439	50	30
48	12	9·696334	6 22	10·303666	9·757931	6 29	10·242069	10·061598	6 7	9·938402	48	12
30	14	9·696444	7 26	10·303556	9·758078	7 34	10·241922	10·061634	7 8	9·938366	46	30
49	16	9·696554	8 29	10·303446	9·758224	8 39	10·241776	10·061670	8 10	9·938330	44	11
30	18	9·696664	9 33	10·303336	9·758371	9 44	10·241629	10·061706	9 11	9·938294	42	30
50	20	9·696775	10 37	10·303225	9·758517	10 49	10·241483	10·061742	10 12	9·938258	40	10
30	22	9·696885	11 40	10·303115	9·758663	11 54	10·241337	10·061779	11 13	9·938221	38	30
51	24	9·696995	12 44	10·303005	9·758810	12 58	10·241190	10·061815	12 14	9·938185	36	9
30	26	9·697105	13 48	10·302895	9·758956	13 63	10·241044	10·061851	13 16	9·938149	34	30
52	28	9·697215	14 51	10·302785	9·759102	14 68	10·240898	10·061887	14 17	9·938113	32	8
30	30	9·697325	15 55	10·302675	9·759248	15 73	10·240752	10·061924	15 18	9·938076	30	30
53	32	9·697435	16 59	10·302565	9·759395	16 78	10·240605	10·061960	16 19	9·938040	28	7
30	34	9·697545	17 62	10·302455	9·759541	17 83	10·240459	10·061996	17 20	9·938004	26	30
54	36	9·697654	18 66	10·302346	9·759687	18 88	10·240313	10·062033	18 22	9·937967	24	6
30	38	9·697764	19 70	10·302236	9·759833	19 93	10·240167	10·062069	19 23	9·937931	22	30
55	40	9·697874	20 73	10·302126	9·759979	20 97	10·240021	10·062105	20 24	9·937895	20	5
30	42	9·697984	21 77	10·302016	9·760126	21 102	10·239874	10·062142	21 25	9·937858	18	30
56	44	9·698094	22 81	10·301906	9·760272	22 107	10·239728	10·062178	22 26	9·937822	16	4
30	46	9·698203	23 84	10·301797	9·760418	23 112	10·239582	10·062214	23 28	9·937786	14	30
57	48	9·698313	24 88	10·301687	9·760564	24 117	10·239436	10·062251	24 29	9·937749	12	3
30	50	9·698423	25 92	10·301577	9·760710	25 122	10·239290	10·062287	25 30	9·937713	10	30
58	52	9·698532	26 95	10·301468	9·760856	26 127	10·239144	10·062324	26 31	9·937676	8	2
30	54	9·698642	27 99	10·301358	9·761002	27 131	10·238998	10·062360	27 32	9·937640	6	30
59	56	9·698751	28 103	10·301249	9·761148	28 136	10·238852	10·062396	28 34	9·937604	4	1
30	58	9·698861	29 106	10·301139	9·761293	29 141	10·238707	10·062433	29 35	9·937567	2	30
60	**60**	9·698970	30 110	10·301030	9·761439	30 146	10·238561	10·062469	30 36	9·937531	0	0
′ ″	m. s	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s	′ ″

60° 4h 0m

LOG. SINES, COSINES, &c.

2h 0m — 30°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·698970		10·301030	9·761439		10·238561	10·062469		9·937531	60	60
30	2	9·699079	1″ 4	10·300921	9·761585	1″ 5	10·238415	10·062506	1″ 1	9·937494	58	30
1	4	9·699189	2 7	10·300811	9·761731	2 10	10·238269	10·062542	2 2	9·937458	56	59
30	6	9·699298	3 11	10·300702	9·761877	3 15	10·238123	10·062579	3 4	9·937421	54	30
2	8	9·699407	4 14	10·300593	9·762023	4 19	10·237977	10·062615	4 5	9·937385	52	58
30	10	9·699517	5 18	10·300483	9·762168	5 24	10·237832	10·062652	5 6	9·937348	50	30
3	12	9·699626	6 22	10·300374	9·762314	6 29	10·237686	10·062688	6 7	9·937312	48	57
30	14	9·699735	7 25	10·300265	9·762460	7 34	10·237540	10·062725	7 9	9·937275	46	30
4	16	9·699844	8 29	10·300156	9·762606	8 39	10·237394	10·062762	8 10	9·937238	44	56
30	18	9·699953	9 33	10·300047	9·762751	9 44	10·237249	10·062798	9 11	9·937202	42	30
5	20	9·700062	10 36	10·299938	9·762897	10 48	10·237103	10·062835	10 12	9·937165	40	55
30	22	9·700171	11 40	10·299829	9·763043	11 53	10·236957	10·062871	11 13	9·937129	38	30
6	24	9·700280	12 44	10·299720	9·763188	12 58	10·236812	10·062908	12 15	9·937092	36	54
30	26	9·700389	13 47	10·299611	9·763334	13 63	10·236666	10·062944	13 16	9·937056	34	30
7	28	9·700498	14 51	10·299502	9·763479	14 68	10·236521	10·062981	14 17	9·937019	32	53
30	30	9·700607	15 54	10·299393	9·763625	15 73	10·236375	10·063018	15 18	9·936982	30	30
8	32	9·700716	16 58	10·299284	9·763770	16 78	10·236230	10·063054	16 20	9·936946	28	52
30	34	9·700825	17 62	10·299175	9·763916	17 82	10·236084	10·063091	17 21	9·936909	26	30
9	36	9·700933	18 65	10·299067	9·764061	18 87	10·235939	10·063128	18 22	9·936872	24	51
30	38	9·701042	19 69	10·298958	9·764207	19 92	10·235793	10·063164	19 23	9·936836	22	30
10	40	9·701151	20 72	10·298849	9·764352	20 97	10·235648	10·063201	20 24	9·936799	20	50
30	42	9·701259	21 76	10·298741	9·764497	21 102	10·235503	10·063238	21 26	9·936762	18	30
11	44	9·701368	22 80	10·298632	9·764643	22 107	10·235357	10·063275	22 27	9·936725	16	49
30	46	9·701477	23 83	10·298523	9·764788	23 112	10·235212	10·063311	23 28	9·936689	14	30
12	48	9·701585	24 87	10·298415	9·764933	24 116	10·235067	10·063348	24 29	9·936652	12	48
30	50	9·701694	25 91	10·298306	9·765079	25 121	10·234921	10·063385	25 31	9·936615	10	30
13	52	9·701802	26 94	10·298198	9·765224	26 126	10·234776	10·063422	26 32	9·936578	8	47
30	54	9·701911	27 98	10·298089	9·765369	27 131	10·234631	10·063458	27 33	9·936542	6	30
14	56	9·702019	28 101	10·297981	9·765514	28 136	10·234486	10·063495	28 34	9·936505	4	46
30	58	9·702127	29 105	10·297873	9·765660	29 141	10·234340	10·063532	29 35	9·936468	2	30
15	1	9·702236	30 109	10·297764	9·765805	30 145	10·234195	10·063569	30 37	9·936431	59	45
30	2	9·702344	1 4	10·297656	9·765950	1 5	10·234050	10·063606	1 1	9·936394	58	30
16	4	9·702452	2 7	10·297548	9·766095	2 10	10·233905	10·063643	2 2	9·936357	56	44
30	6	9·702561	3 11	10·297439	9·766240	3 14	10·233760	10·063680	3 4	9·936320	54	30
17	8	9·702669	4 14	10·297331	9·766385	4 19	10·233615	10·063716	4 5	9·936284	52	43
30	10	9·702777	5 18	10·297223	9·766530	5 24	10·233470	10·063753	5 6	9·936247	50	30
18	12	9·702885	6 22	10·297115	9·766675	6 29	10·233325	10·063790	6 7	9·936210	48	42
30	14	9·702993	7 25	10·297007	9·766820	7 34	10·233180	10·063827	7 9	9·936173	46	30
19	16	9·703101	8 29	10·296899	9·766965	8 39	10·233035	10·063864	8 10	9·936136	44	41
30	18	9·703209	9 32	10·296791	9·767110	9 43	10·232890	10·063901	9 11	9·936099	42	30
20	20	9·703317	10 36	10·296683	9·767255	10 48	10·232745	10·063938	10 12	9·936062	40	40
30	22	9·703425	11 39	10·296575	9·767400	11 53	10·232600	10·063975	11 14	9·936025	38	30
21	24	9·703533	12 43	10·296467	9·767545	12 58	10·232455	10·064012	12 15	9·935988	36	39
30	26	9·703641	13 47	10·296359	9·767690	13 63	10·232310	10·064049	13 16	9·935951	34	30
22	28	9·703749	14 50	10·296251	9·767834	14 68	10·232166	10·064086	14 17	9·935914	32	38
30	30	9·703856	15 54	10·296144	9·767979	15 72	10·232021	10·064123	15 18	9·935877	30	30
23	32	9·703964	16 57	10·296036	9·768124	16 77	10·231876	10·064160	16 20	9·935840	28	37
30	34	9·704072	17 61	10·295928	9·768269	17 82	10·231731	10·064197	17 21	9·935803	26	30
24	36	9·704179	18 64	10·295821	9·768414	18 87	10·231586	10·064234	18 22	9·935766	24	36
30	38	9·704287	19 68	10·295713	9·768558	19 92	10·231442	10·064271	19 24	9·935729	22	30
25	40	9·704395	20 72	10·295605	9·768703	20 97	10·231297	10·064308	20 25	9·935692	20	35
30	42	9·704502	21 75	10·295498	9·768848	21 101	10·231152	10·064345	21 26	9·935655	18	30
26	44	9·704610	22 79	10·295390	9·768992	22 106	10·231008	10·064382	22 27	9·935618	16	34
30	46	9·704717	23 83	10·295283	9·769137	23 111	10·230863	10·064419	23 28	9·935581	14	30
27	48	9·704825	24 86	10·295175	9·769281	24 116	10·230719	10·064457	24 30	9·935543	12	33
30	50	9·704932	25 90	10·295068	9·769426	25 121	10·230574	10·064494	25 31	9·935506	10	30
28	52	9·705040	26 93	10·294960	9·769571	26 126	10·230429	10·064531	26 32	9·935469	8	32
30	54	9·705147	27 97	10·294853	9·769715	27 130	10·230285	10·064568	27 33	9·935432	6	30
29	56	9·705254	28 100	10·294746	9·769860	28 135	10·230140	10·064605	28 35	9·935395	4	31
30	58	9·705362	29 104	10·294638	9·770004	29 140	10·229996	10·064642	29 36	9·935358	2	30
30	2	9·705469	30 108	10·294531	9·770148	30 145	10·229852	10·064680	30 37	9·935320	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

59° — 3h 58m

LOG. SINES, COSINES, &c.

$2^h\ 2^m$ 30°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
30	0	9·705469		10·294531	9·770148		10·229852	10·064680		9·935320	**58**	30
30	2	9·705576	1″ 4	10·294424	9·770293	1″ 5	10·229707	10·064717	1″ 1	9·935283	58	30
31	4	9·705683	2 7	10·294317	9·770437	2 10	10·229563	10·064754	2 2	9·935246	56	29
30	6	9·705790	3 11	10·294210	9·770582	3 14	10·229418	10·064791	3 4	9·935209	54	30
32	8	9·705898	4 14	10·294102	9·770726	4 19	10·229274	10·064829	4 5	9·935171	52	28
30	10	9·706005	5 18	10·293995	9·770870	5 24	10·229130	10·064866	5 6	9·935134	50	30
33	12	9·706112	6 21	10·293888	9·771015	6 29	10·228985	10·064903	6 7	9·935097	48	27
30	14	9·706219	7 25	10·293781	9·771159	7 34	10·228841	10·064940	7 9	9·935060	46	30
34	16	9·706326	8 28	10·293674	9·771303	8 38	10·228697	10·064978	8 10	9·935022	44	26
30	18	9·706433	9 32	10·293567	9·771448	9 43	10·228552	10·065015	9 11	9·934985	42	30
35	20	9·706539	10 36	10·293461	9·771592	10 48	10·228408	10·065052	10 12	9·934948	40	25
30	22	9·706646	11 39	10·293354	9·771736	11 53	10·228264	10·065090	11 14	9·934910	38	30
36	24	9·706753	12 43	10·293247	9·771880	12 58	10·228120	10·065127	12 15	9·934873	36	24
30	26	9·706860	13 46	10·293140	9·772024	13 62	10·227976	10·065165	13 16	9·934836	34	30
37	28	9·706967	14 50	10·293033	9·772168	14 67	10·227832	10·065202	14 17	9·934798	32	23
30	30	9·707073	15 53	10·292927	9·772312	15 72	10·227688	10·065239	15 19	9·934761	30	30
38	32	9·707180	16 57	10·292820	9·772457	16 77	10·227543	10·065277	16 20	9·934723	28	22
30	34	9·707287	17 61	10·292713	9·772601	17 82	10·227399	10·065314	17 21	9·934686	26	30
39	36	9·707393	18 64	10·292607	9·772745	18 86	10·227255	10·065351	18 22	9·934649	24	21
30	38	9·707500	19 68	10·292500	9·772889	19 91	10·227111	10·065389	19 24	9·934611	22	30
40	40	9·707606	20 71	10·292394	9·773033	20 96	10·226967	10·065426	20 25	9·934574	20	20
30	42	9·707713	21 75	10·292287	9·773177	21 101	10·226823	10·065464	21 26	9·934536	18	30
41	44	9·707819	22 78	10·292181	9·773321	22 106	10·226679	10·065501	22 27	9·934499	16	19
30	46	9·707926	23 82	10·292074	9·773465	23 110	10·226535	10·065539	23 29	9·934461	14	30
42	48	9·708032	24 85	10·291968	9·773608	24 115	10·226392	10·065576	24 30	9·934424	12	18
30	50	9·708139	25 89	10·291861	9·773752	25 120	10·226248	10·065614	25 31	9·934386	10	30
43	52	9·708245	26 92	10·291755	9·773896	26 125	10·226104	10·065651	26 32	9·934349	8	17
30	54	9·708351	27 96	10·291649	9·774040	27 130	10·225960	10·065689	27 34	9·934311	6	30
44	56	9·708458	28 99	10·291542	9·774184	28 134	10·225816	10·065726	28 35	9·934274	4	16
30	58	9·708564	29 103	10·291436	9·774328	29 139	10·225672	10·065764	29 36	9·934236	2	30
45	**3**	9·708670	30 107	10·291330	9·774471	30 144	10·225529	10·065801	30 37	9·934199	**57**	15
30	2	9·708776	1 4	10·291224	9·774615	1 5	10·225385	10·065839	1 1	9·934161	58	30
46	4	9·708882	2 7	10·291118	9·774759	2 10	10·225241	10·065877	2 3	9·934123	56	14
30	6	9·708988	3 11	10·291012	9·774902	3 14	10·225098	10·065914	3 4	9·934086	54	30
47	8	9·709094	4 14	10·290906	9·775046	4 19	10·224954	10·065952	4 5	9·934048	52	13
30	10	9·709200	5 18	10·290800	9·775190	5 24	10·224810	10·065989	5 6	9·934011	50	30
48	12	9·709306	6 21	10·290694	9·775333	6 29	10·224667	10·066027	6 8	9·933973	48	12
30	14	9·709412	7 25	10·290588	9·775477	7 33	10·224523	10·066065	7 9	9·933935	46	30
49	16	9·709518	8 28	10·290482	9·775621	8 38	10·224379	10·066102	8 10	9·933898	44	11
30	18	9·709624	9 32	10·290376	9·775764	9 43	10·224236	10·066140	9 11	9·933860	42	30
60	20	9·709730	10 35	10·290270	9·775908	10 48	10·224092	10·066178	10 13	9·933822	40	10
30	22	9·709836	11 39	10·290164	9·776051	11 53	10·223949	10·066216	11 14	9·933784	38	30
51	24	9·709941	12 42	10·290059	9·776195	12 57	10·223805	10·066253	12 15	9·933747	36	9
30	26	9·710047	13 46	10·289953	9·776338	13 62	10·223662	10·066291	13 16	9·933709	34	30
52	28	9·710153	14 49	10·289847	9·776482	14 67	10·223518	10·066329	14 18	9·933671	32	8
30	30	9·710259	15 53	10·289741	9·776625	15 72	10·223375	10·066367	15 19	9·933633	30	30
53	32	9·710364	16 56	10·289636	9·776768	16 76	10·223232	10·066404	16 20	9·933596	28	7
30	34	9·710470	17 60	10·289530	9·776912	17 81	10·223088	10·066442	17 21	9·933558	26	30
54	36	9·710575	18 63	10·289425	9·777055	18 86	10·222945	10·066480	18 23	9·933520	24	6
30	38	9·710681	19 67	10·289319	9·777199	19 91	10·222801	10·066518	19 24	9·933482	22	30
55	40	9·710786	20 70	10·289214	9·777342	20 96	10·222658	10·066555	20 25	9·933445	20	5
30	42	9·710892	21 74	10·289108	9·777485	21 100	10·222515	10·066593	21 26	9·933407	18	30
56	44	9·710997	22 77	10·289003	9·777628	22 105	10·222372	10·066631	22 28	9·933369	16	4
30	46	9·711103	23 81	10·288897	9·777772	23 110	10·222228	10·066669	23 29	9·933331	14	30
57	48	9·711208	24 85	10·288792	9·777915	24 115	10·222085	10·066707	24 30	9·933293	12	3
30	50	9·711313	25 88	10·288687	9·778058	25 119	10·221942	10·066745	25 32	9·933255	10	30
58	52	9·711419	26 92	10·288581	9·778201	26 124	10·221799	10·066783	26 33	9·933217	8	2
30	54	9·711524	27 95	10·288476	9·778344	27 129	10·221656	10·066821	27 34	9·933179	6	30
59	56	9·711629	28 99	10·288371	9·778488	28 134	10·221512	10·066859	28 35	9·933141	4	1
30	58	9·711734	29 102	10·288266	9·778631	29 139	10·221369	10·066896	29 37	9·933104	2	30
60	**4**	9·711839	30 106	10·288161	9·778774	30 143	10·221226	10·066934	30 38	9·933066	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

59° $3^h\ 56^m$

LOG. SINES, COSINES, &c.

2ʰ 4ᵐ — 31°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·711839		10·288161	9·778774		10·221226	10·066934		9·933066	56	60
30	2	9·711944	1″ 3	10·288056	9·778917	1″ 5	10·221083	10·066972	1″ 1	9·933028	58	30
1	4	9·712050	2 7	10·287950	9·779060	2 10	10·220940	10·067010	2 3	9·932990	56	59
30	6	9·712155	3 10	10·287845	9·779203	3 14	10·220797	10·067048	3 4	9·932952	54	30
2	8	9·712260	4 14	10·287740	9·779346	4 19	10·220654	10·067086	4 5	9·932914	52	58
30	10	9·712365	5 17	10·287635	9·779489	5 24	10·220511	10·067124	5 6	9·932876	50	30
3	12	9·712469	6 21	10·287531	9·779632	6 29	10·220368	10·067162	6 8	9·932838	48	57
30	14	9·712574	7 24	10·287426	9·779775	7 33	10·220225	10·067200	7 9	9·932800	46	30
4	16	9·712679	8 28	10·287321	9·779918	8 38	10·220082	10·067238	8 10	9·932762	44	56
30	18	9·712784	9 31	10·287216	9·780061	9 43	10·219939	10·067276	9 11	9·932724	42	30
5	20	9·712889	10 35	10·287111	9·780203	10 48	10·219797	10·067315	10 13	9·932685	40	55
30	22	9·712994	11 38	10·287006	9·780346	11 52	10·219654	10·067353	11 14	9·932647	38	30
6	24	9·713098	12 42	10·286902	9·780489	12 57	10·219511	10·067391	12 15	9·932609	36	54
30	26	9·713203	13 45	10·286797	9·780632	13 62	10·219368	10·067429	13 17	9·932571	34	30
7	28	9·713308	14 49	10·286692	9·780775	14 67	10·219225	10·067467	14 18	9·932533	32	53
30	30	9·713412	15 52	10·286588	9·780917	15 71	10·219083	10·067505	15 19	9·932495	30	30
8	32	9·713517	16 56	10·286483	9·781060	16 76	10·218940	10·067543	16 20	9·932457	28	52
30	34	9·713621	17 59	10·286379	9·781203	17 81	10·218797	10·067581	17 22	9·932419	26	31
9	36	9·713726	18 63	10·286274	9·781346	18 86	10·218654	10·067620	18 23	9·932380	24	51
30	38	9·713831	19 66	10·286169	9·781488	19 90	10·218512	10·067658	19 24	9·932342	22	30
10	40	9·713935	20 70	10·286065	9·781631	20 95	10·218369	10·067696	20 25	9·932304	20	50
30	42	9·714039	21 73	10·285961	9·781774	21 100	10·218226	10·067734	21 27	9·932266	18	30
11	44	9·714144	22 77	10·285856	9·781916	22 105	10·218084	10·067772	22 28	9·932228	16	49
30	46	9·714248	23 80	10·285752	9·782059	23 109	10·217941	10·067811	23 29	9·932189	14	30
12	48	9·714352	24 84	10·285648	9·782201	24 114	10·217799	10·067849	24 30	9·932151	12	48
30	50	9·714457	25 87	10·285543	9·782344	25 119	10·217656	10·067887	25 32	9·932113	10	30
13	52	9·714561	26 91	10·285439	9·782486	26 124	10·217514	10·067925	26 33	9·932075	8	47
30	54	9·714665	27 94	10·285335	9·782629	27 129	10·217371	10·067964	27 34	9·932036	6	30
14	56	9·714769	28 98	10·285231	9·782771	28 133	10·217229	10·068002	28 36	9·931998	4	46
30	58	9·714873	29 101	10·285127	9·782914	29 138	10·217086	10·068040	29 37	9·931960	2	30
15	5	9·714978	30 105	10·285022	9·783056	30 143	10·216944	10·068079	30 38	9·931921	55	45
30	2	9·715082	1 3	10·284918	9·783199	1 5	10·216801	10·068117	1 1	9·931883	58	30
16	4	9·715186	2 7	10·284814	9·783341	2 9	10·216659	10 068155	2 3	9·931845	56	44
30	6	9·715290	3 10	10·284710	9·783483	3 14	10·216517	10·068194	3 4	9·931806	54	30
17	8	9·715394	4 14	10·284606	9·783626	4 19	10·216374	10·068232	4 5	9·931768	52	43
30	10	9·715498	5 17	10·284502	9·783768	5 24	10·216232	10·068270	5 6	9·931730	50	30
18	12	9·715602	6 21	10·284398	9·783910	6 28	10·216090	10·068309	6 8	9·931691	48	42
30	14	9·715705	7 24	10·284295	9·784053	7 33	10·215947	10·068347	7 9	9·931653	46	30
19	16	9·715809	8 28	10·284191	9·784195	8 38	10·215805	10·068386	8 10	9·931614	44	41
30	18	9·715913	9 31	10·284087	9·784337	9 43	10·215663	10·068424	9 12	9·931576	42	30
20	20	9·716017	10 35	10·283983	9·784479	10 47	10·215521	10·068463	10 13	9·931537	40	40
30	22	9·716121	11 38	10·283879	9·784622	11 52	10·215378	10·068501	11 14	9·931499	38	39
21	24	9·716224	12 42	10·283776	9·784764	12 57	10·215236	10·068540	12 15	9·931460	36	39
30	26	9·716328	13 45	10·283672	9·784906	13 62	10·215094	10·068578	13 17	9·931422	34	30
22	28	9·716432	14 49	10·283568	9·785048	14 66	10·214952	10·068617	14 18	9·931383	32	38
30	30	9·716535	15 52	10·283465	9·785190	15 71	10·214810	10·068655	15 19	9 931345	30	30
23	32	9·716639	16 56	10·283361	9·785332	16 76	10·214668	10·068694	16 21	9·931306	28	37
30	34	9·716742	17 59	10·283258	9·785474	17 81	10·214526	10·068732	17 22	9·931268	26	30
24	36	9·716846	18 63	10·283154	9·785616	18 85	10·214384	10·068771	18 23	9·931229	24	36
30	38	9·716949	19 66	10·283051	9·785758	19 90	10·214242	10·068809	19 24	9·931191	22	30
25	40	9·717053	20 69	10·282947	9·785900	20 95	10·214100	10·068848	20 26	9·931152	20	35
30	42	9·717156	21 72	10·282844	9·786042	21 100	10·213958	10·068886	21 27	9·931114	18	30
26	44	9·717259	22 76	10·282741	9·786184	22 104	10·213816	10·068925	22 28	9·931075	16	34
30	46	9·717363	23 79	10·282637	9·786326	23 109	10·213674	10·068964	23 30	9·931036	14	30
27	48	9·717466	24 83	10·282534	9·786468	24 114	10·213532	10·069002	24 31	9·930998	12	33
30	50	9·717569	25 86	10·282431	9·786610	25 118	10·213390	10·069041	25 32	9·930959	10	30
28	52	9·717673	26 90	10·282327	9·786752	26 123	10·213248	10·069079	26 33	9·930921	8	32
30	54	9·717776	27 93	10·282224	9·786894	27 128	10·213106	10·069118	27 35	9·930882	6	30
29	56	9·717879	28 97	10·282121	9·787036	28 133	10·212964	10·069157	28 36	9·930843	4	31
30	58	9·717982	29 100	10·282018	9·787178	29 137	10·212822	10·069196	29 37	9·930804	2	30
30	6	9·718085	30 104	10·281915	9·787319	30 142	10·212681	10·069234	30 39	9·930766	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

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LOG. SINES, COSINES, &c.

$2^h\ 6^m$ 31°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
30	0	9·718085		10·281915	9·787319		10·212681	10·069234		9·930766	54	30
30	2	9·718188	1″ 3	10·281812	9·787461	1″ 5	10·212539	10·069273	1″ 1	9·930727	58	30
31	4	9·718291	2 7	10·281709	9·787603	2 9	10·212397	10·069312	2 3	9·930688	56	29
30	6	9·718394	3 10	10·281606	9·787745	3 14	10·212255	10·069350	3 4	9·930650	54	30
32	8	9·718497	4 14	10·281503	9·787886	4 19	10·212114	10·069389	4 5	9·930611	52	28
30	10	9·718600	5 17	10·281400	9·788028	5 24	10·211972	10·069428	5 6	9·930572	50	30
33	12	9·718703	6 20	10·281297	9·788170	6 28	10·211830	10·069467	6 8	9·930533	48	27
30	14	9·718806	7 24	10·281194	9·788311	7 33	10·211689	10·069506	7 9	9·930495	46	30
34	16	9·718909	8 27	10·281091	9·788453	8 38	10·211547	10·069544	8 10	9·930456	44	26
30	18	9·719011	9 31	10·280989	9·788595	9 42	10·211405	10·069583	9 12	9·930417	42	30
35	20	9·719114	10 34	10·280886	9·788736	10 47	10·211264	10·069622	10 13	9·930378	40	25
30	22	9·719217	11 38	10·280783	9·788878	11 52	10·211122	10·069661	11 14	9·930339	38	30
36	24	9·719320	12 41	10·280680	9·789019	12 57	10·210981	10·069700	12 16	9·930300	36	24
30	26	9·719422	13 44	10·280578	9·789161	13 61	10·210839	10·069739	13 17	9·930262	34	30
37	28	9·719525	14 48	10·280475	9·789302	14 66	10·210698	10·069777	14 18	9·930223	32	23
30	30	9·719627	15 51	10·280372	9·789444	15 71	10·210556	10·069816	15 20	9·930184	30	30
38	32	9·719730	16 55	10·280270	9·789585	16 75	10·210415	10·069855	16 21	9·930145	28	22
30	34	9·719833	17 58	10·280167	9·789727	17 80	10·210273	10·069894	17 22	9·930106	26	30
39	36	9·719935	18 62	10·280065	9·789868	18 85	10·210132	10·069933	18 23	9·930067	24	21
30	38	9·720038	19 65	10·279962	9·790009	19 89	10·209991	10·069972	19 25	9·930028	22	30
40	40	9·720140	20 68	10·279860	9·790151	20 94	10·209849	10·070011	20 26	9·929989	20	20
30	42	9·720242	21 72	10·279758	9·790292	21 99	10·209708	10·070050	21 27	9·929950	18	30
41	44	9·720345	22 75	10·279655	9·790434	22 104	10·209566	10·070089	22 29	9·929911	16	19
30	46	9·720447	23 79	10·279553	9·790575	23 108	10·209425	10·070128	23 30	9·929872	14	30
42	48	9·720549	24 82	10·279451	9·790716	24 113	10·209284	10·070167	24 31	9·929833	12	18
30	50	9·720652	25 86	10·279348	9·790857	25 118	10·209143	10·070206	25 32	9·929794	10	30
43	52	9·720754	26 89	10·279246	9·790999	26 122	10·209001	10·070245	26 34	9·929755	8	17
30	54	9·720856	27 92	10·279144	9·791140	27 127	10·208860	10·070284	27 35	9·929716	6	30
44	56	9·720958	28 96	10·279042	9·791281	28 132	10·208719	10·070323	28 36	9·929677	4	16
30	58	9·721060	29 99	10·278940	9·791422	29 137	10·208578	10·070362	29 38	9·929638	2	30
45	**7**	9·721162	30 103	10·278838	9·791563	30 141	10·208437	10·070401	30 39	9·929599	**53**	15
30	2	9·721264	1 3	10·278736	9·791705	1 5	10·208295	10·070440	1 1	9·929560	58	30
46	4	9·721366	2 7	10·278634	9·791846	2 9	10·208154	10·070479	2 3	9·929521	56	14
30	6	9·721468	3 10	10·278532	9·791987	3 14	10·208013	10·070518	3 4	9·929482	54	30
47	8	9·721570	4 14	10·278430	9·792128	4 19	10·207872	10·070558	4 5	9·929442	52	13
30	10	9·721672	5 17	10·278328	9·792269	5 23	10·207731	10·070597	5 6	9·929403	50	30
48	12	9·721774	6 20	10·278226	9·792410	6 28	10·207590	10·070636	6 8	9·929364	48	12
30	14	9·721876	7 24	10·278124	9·792551	7 33	10·207449	10·070675	7 9	9·929325	46	30
49	16	9·721978	8 27	10·278022	9·792692	8 38	10·207308	10·070714	8 10	9·929286	44	11
30	18	9·722080	9 30	10·277920	9·792833	9 42	10·207167	10·070754	9 12	9·929247	42	30
50	20	9·722181	10 34	10·277819	9·792974	10 47	10·207026	10·070793	10 13	9·929207	40	10
30	22	9·722283	11 37	10·277717	9·793115	11 52	10·206885	10·070832	11 14	9·929168	38	30
51	24	9·722385	12 41	10·277615	9·793256	12 56	10·206744	10·070871	12 16	9·929129	36	9
30	26	9·722487	13 44	10·277513	9·793397	13 61	10·206603	10·070910	13 17	9·929090	34	30
52	28	9·722588	14 48	10·277412	9·793538	14 66	10·206462	10·070950	14 18	9·929050	32	8
30	30	9·722690	15 51	10·277310	9·793679	15 70	10·206321	10·070989	15 20	9·929011	30	30
53	32	9·722791	16 55	10·277209	9·793819	16 75	10·206181	10·071028	16 21	9·928972	28	7
30	34	9·722893	17 58	10·277107	9·793960	17 80	10·206040	10·071068	17 22	9·928933	26	30
54	36	9·722994	18 61	10·277006	9·794101	18 84	10·205899	10·071107	18 24	9·928893	24	6
30	38	9·723096	19 64	10·276904	9·794242	19 89	10·205758	10·071146	19 25	9·928854	22	30
55	40	9·723197	20 68	10·276803	9·794383	20 94	10·205617	10·071185	20 26	9·928815	20	5
30	42	9·723299	21 71	10·276701	9·794523	21 98	10·205477	10·071225	21 28	9·928775	18	30
56	44	9·723400	22 75	10·276600	9·794664	22 103	10·205336	10·071264	22 29	9·928736	16	4
30	46	9·723501	23 78	10·276499	9·794805	23 108	10·205195	10·071304	23 30	9·928696	14	30
57	48	9·723603	24 82	10·276397	9·794946	24 113	10·205054	10·071343	24 31	9·928657	12	3
30	50	9·723704	25 85	10·276296	9·795086	25 117	10·204914	10·071382	25 33	9·928618	10	30
58	52	9·723805	26 89	10·276195	9·795227	26 122	10·204773	10·071422	26 34	9·928578	8	2
30	54	9·723906	27 92	10·276094	9·795367	27 127	10·204633	10·071461	27 35	9·928539	6	30
59	56	9·724007	28 95	10·275993	9·795508	28 131	10·204492	10·071501	28 37	9·928499	4	1
30	58	9·724109	29 98	10·275891	9·795649	29 136	10·204351	10·071540	29 38	9·928460	2	30
60	**8**	9·724210	30 102	10·275790	9·795789	30 141	10·204211	10·071580	30 39	9·928420	0	0
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

58° $3^h\ 52^m$

LOG. SINES, COSINES, &c.

2ʰ 8ᵐ — 32°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·724210		10·275790	9·795789		10·204211	10·071580		9·928420	**52**	60
30	2	9·724311	1″ 3	10·275689	9·795930	1″ 5	10·204070	10·071619	1″ 1	9·928381	58	30
1	4	9·724412	2 7	10·275588	9·796070	2 9	10·203930	10·071658	2 3	9·928342	56	59
30	6	9·724513	3 10	10·275487	9·796211	3 14	10·203789	10·071698	3 4	9·928302	54	30
2	8	9·724614	4 13	10·275386	9·796351	4 19	10·203649	10·071737	4 5	9·928263	52	58
30	10	9·724715	5 17	10·275285	9·796494	5 23	10·203508	10·071777	5 7	9·928223	50	30
3	12	9·724816	6 20	10·275184	9·796632	6 28	10·203368	10·071817	6 8	9·928183	48	57
30	14	9·724917	7 23	10·275083	9·796773	7 33	10·203227	10·071856	7 9	9·928144	46	30
4	16	9·725017	8 27	10·274983	9·796913	8 37	10·203087	10·071896	8 11	9·928104	44	56
30	18	9·725118	9 30	10·274882	9·797053	9 42	10·202947	10·071935	9 12	9·928065	42	30
5	20	9·725219	10 34	10·274781	9·797194	10 47	10·202806	10·071975	10 13	9·928025	40	55
30	22	9·725320	11 37	10·274680	9·797334	11 51	10·202666	10·072015	11 15	9·927986	38	30
6	24	9·725420	12 40	10·274580	9·797475	12 56	10·202526	10·072054	12 16	9·927946	36	54
30	26	9·725521	13 44	10·274479	9·797615	13 61	10·202385	10·072094	13 17	9·927906	34	30
7	28	9·725622	14 47	10·274378	9·797755	14 65	10·202245	10·072133	14 18	9·927867	32	53
30	30	9·725722	15 50	10·274278	9·797895	15 70	10·202105	10·072173	15 20	9·927827	30	30
8	32	9·725823	16 54	10·274177	9·798036	16 75	10·201964	10·072213	16 21	9·927787	28	52
30	34	9·725923	17 57	10·274076	9·798176	17 79	10·201824	10·072252	17 22	9·927748	26	30
9	36	9·726024	18 61	10·273976	9·798316	18 84	10·201684	10·072292	18 24	9·927708	24	51
30	38	9·726124	19 64	10·273875	9·798456	19 89	10·201544	10·072332	19 25	9·927668	22	30
10	40	9·726225	20 67	10·273775	9·798596	20 93	10·201404	10·072371	20 26	9·927629	20	50
30	42	9·726325	21 70	10·273675	9·798737	21 98	10·201264	10·072411	21 28	9·927589	18	30
11	44	9·726426	22 74	10·273574	9·798877	22 103	10·201123	10·072451	22 29	9·927549	16	49
30	46	9·726526	23 77	10·273474	9·799017	23 107	10·200983	10·072491	23 30	9·927509	14	30
12	48	9·726626	24 80	10·273374	9·799157	24 112	10·200843	10·072530	24 32	9·927470	12	48
30	50	9·726727	25 84	10·273273	9·799297	25 117	10·200703	10·072570	25 33	9·927430	10	30
13	52	9·726827	26 87	10·273173	9·799437	26 122	10·200563	10·072610	26 34	9·927390	8	47
30	54	9·726927	27 90	10·273073	9·799577	27 126	10·200423	10·072650	27 36	9·927350	6	30
14	56	9·727027	28 94	10·272973	9·799717	28 131	10·200283	10·072690	28 37	9·927310	4	46
30	58	9·727128	29 97	10·272872	9·799857	29 136	10·200143	10·072730	29 38	9·927270	2	30
15	**9**	9·727228	30 101	10·272772	9·799997	30 140	10·200003	10·072769	30 40	9·927231	**51**	45
30	2	9·727328	1 3	10·272672	9·800137	1 5	10·199863	10·072809	1 1	9·927191	58	30
16	4	9·727428	2 7	10·272572	9·800277	2 9	10·199723	10·072849	2 3	9·927151	56	44
30	6	9·727528	3 10	10·272472	9·800417	3 14	10·199583	10·072889	3 4	9·927111	54	30
17	8	9·727628	4 13	10·272372	9·800557	4 19	10·199443	10·072929	4 5	9·927071	52	43
30	10	9·727728	5 17	10·272272	9·800697	5 23	10·199303	10·072969	5 7	9·927031	50	30
18	12	9·727828	6 20	10·272172	9·800836	6 28	10·199164	10·073009	6 8	9·926991	48	42
30	14	9·727928	7 23	10·272072	9·800976	7 33	10·199024	10·073049	7 9	9·926951	46	30
19	16	9·728027	8 27	10·271972	9·801116	8 37	10·198884	10·073089	8 11	9·926911	44	41
30	18	9·728127	9 30	10·271873	9·801256	9 42	10·198744	10·073129	9 12	9·926871	42	30
20	20	9·728227	10 33	10·271773	9·801396	10 46	10·198604	10·073169	10 13	9·926831	40	40
30	22	9·728327	11 37	10·271673	9·801535	11 51	10·198465	10·073209	11 15	9·926791	38	30
21	24	9·728427	12 40	10·271573	9·801675	12 56	10·198325	10·073249	12 16	9·926751	36	39
30	26	9·728526	13 43	10·271474	9·801815	13 60	10·198185	10·073289	13 17	9·926711	34	30
22	28	9·728626	14 47	10·271374	9·801955	14 65	10·198045	10·073329	14 19	9·926671	32	38
30	30	9·728726	15 50	10·271274	9·802094	15 70	10·197906	10·073369	15 20	9·926631	30	30
23	32	9·728825	16 53	10·271175	9·802234	16 74	10·197766	10·073409	16 21	9·926591	28	37
30	34	9·728925	17 56	10·271075	9·802374	17 79	10·197626	10·073449	17 23	9·926551	26	30
24	36	9·729024	18 59	10·270976	9·802513	18 84	10·197487	10·073489	18 24	9·926511	24	36
30	38	9·729124	19 63	10·270876	9·802653	19 88	10·197347	10·073529	19 25	9·926471	22	30
25	40	9·729223	20 66	10·270777	9·802792	20 93	10·197208	10·073569	20 27	9·926431	20	35
30	42	9·729323	21 70	10·270677	9·802932	21 98	10·197068	10·073609	21 28	9·926391	18	30
26	44	9·729422	22 73	10·270578	9·803072	22 102	10·196928	10·073649	22 29	9·926351	16	34
30	46	9·729522	23 76	10·270478	9·803211	23 107	10·196789	10·073689	23 31	9·926311	14	30
27	48	9·729621	24 80	10·270379	9·803351	24 112	10·196649	10·073730	24 32	9·926270	12	33
30	50	9·729720	25 83	10·270280	9·803490	25 116	10·196510	10·073770	25 33	9·926230	10	30
28	52	9·729820	26 86	10·270180	9·803630	26 121	10·196370	10·073810	26 35	9·926190	8	32
30	54	9·729919	27 90	10·270081	9·803769	27 126	10·196231	10·073850	27 36	9·926150	6	30
29	56	9·730018	28 93	10·269982	9·803909	28 130	10·196091	10·073890	28 38	9·926110	4	31
30	58	9·730117	29 96	10·269883	9·804048	29 135	10·195952	10·073931	29 39	9·926069	2	30
30	**10**	9·730217	30 100	10·269784	9·804187	30 139	10·195813	10·073971	30 40	9·926029	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

57° — 3ʰ 50ᵐ

LOG. SINES, COSINES, &c.

2ʰ 10ᵐ 32°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m	′ ″
30	0	9·730217		10·269783	9·804187		10·195813	10·073971		9·926029	50	30
30	2	9·730316	1″ 3	10·269684	9·804327	1″ 5	10·195673	10·074011	1″ 1	9·925989	58	30
31	4	9·730415	2 7	10·269585	9·804466	2 9	10·195534	10·074051	2 3	9·925949	56	29
30	6	9·730514	3 10	10·269486	9·804605	3 14	10·195395	10·074092	3 4	9·925908	54	30
32	8	9·730613	4 13	10·269387	9·804745	4 19	10·195255	10·074132	4 5	9·925868	52	28
30	10	9·730712	5 16	10·269288	9·804884	5 23	10·195116	10·074172	5 7	9·925828	50	30
33	12	9·730811	6 20	10·269189	9·805023	6 28	10·194977	10·074212	6 8	9·925788	48	27
30	14	9·730910	7 23	10·269090	9·805163	7 32	10·194837	10·074253	7 9	9·925747	46	30
34	16	9·731009	8 26	10·268991	9·805302	8 37	10·194698	10·074293	8 11	9·925707	44	26
30	18	9·731108	9 30	10·268892	9·805441	9 42	10·194559	10·074333	9 12	9·925667	42	30
35	20	9·731206	10 33	10·268794	9·805580	10 46	10·194420	10·074374	10 13	9·925626	40	25
30	22	9·731305	11 36	10·268695	9·805719	11 51	10·194281	10·074414	11 15	9·925586	38	30
36	24	9·731404	12 40	10·268596	9·805859	12 56	10·194141	10·074455	12 16	9·925545	36	24
30	26	9·731503	13 43	10·268497	9·805998	13 60	10·194002	10·074495	13 18	9·925505	34	30
37	28	9·731602	14 46	10·268398	9·806137	14 65	10·193863	10·074535	14 19	9·925465	32	23
30	30	9·731700	15 49	10·268300	9·806276	15 70	10·193724	10·074576	15 20	9·925424	30	30
38	32	9·731799	16 53	10·268201	9·806415	16 74	10·193585	10·074616	16 22	9·925384	28	22
30	34	9·731897	17 56	10·268102	9·806554	17 79	10·193446	10·074657	17 23	9·925343	26	30
39	36	9·731996	18 59	10·268004	9·806693	18 83	10·193307	10·074697	18 24	9·925303	24	21
30	38	9·732095	19 63	10·267905	9·806832	19 88	10·193168	10·074738	19 26	9·925262	22	30
40	40	9·732193	20 66	10·267807	9·806971	20 93	10·193029	10·074778	20 27	9·925222	20	20
30	42	9·732292	21 69	10·267708	9·807110	21 97	10·192890	10·074819	21 28	9·925181	18	30
41	44	9·732390	22 73	10·267610	9·807249	22 102	10·192751	10·074859	22 30	9·925141	16	19
30	46	9·732489	23 76	10·267511	9·807388	23 107	10·192612	10·074900	23 31	9·925100	14	30
42	48	9·732587	24 79	10·267413	9·807527	24 111	10·192473	10·074940	24 32	9·925060	12	18
30	50	9·732685	25 82	10·267315	9·807666	25 116	10·192334	10·074981	25 34	9·925019	10	30
43	52	9·732784	26 86	10·267216	9·807805	26 121	10·192195	10·075021	26 35	9·924979	8	17
30	54	9·732882	27 89	10·267118	9·807944	27 125	10·192056	10·075062	27 36	9·924938	6	30
44	56	9·732980	28 92	10·267020	9·808083	28 130	10·191917	10·075103	28 38	9·924897	4	16
30	58	9·733079	29 95	10·266921	9·808222	29 134	10·191778	10·075143	29 39	9·924857	2	30
45	**11**	9·733177	30 99	10·266823	9·808361	30 139	10·191639	10·075184	30 40	9·924816	**49**	15
30	2	9·733275	1 3	10·266725	9·808499	1 5	10·191501	10·075224	1 1	9·924776	58	30
46	4	9·733373	2 6	10·266627	9·808638	2 9	10·191362	10·075265	2 3	9·924735	56	14
30	6	9·733471	3 10	10·266529	9·808777	3 14	10·191223	10·075306	3 4	9·924694	54	30
47	8	9·733569	4 13	10·266431	9·808916	4 18	10·191084	10·075346	4 5	9·924654	52	13
30	10	9·733667	5 16	10·266333	9·809055	5 23	10·190945	10·075387	5 7	9·924613	50	30
48	12	9·733765	6 20	10·266235	9·809193	6 28	10·190807	10·075428	6 8	9·924572	48	12
30	14	9·733863	7 23	10·266137	9·809332	7 32	10·190668	10·075469	7 10	9·924531	46	30
49	16	9·733961	8 26	10·266039	9·809471	8 37	10·190529	10·075509	8 11	9·924491	44	11
30	18	9·734059	9 29	10·265941	9·809609	9 42	10·190391	10·075550	9 12	9·924450	42	30
50	20	9·734157	10 33	10·265843	9·809748	10 46	10·190252	10·075591	10 14	9·924409	40	10
30	22	9·734255	11 36	10·265745	9·809887	11 51	10·190113	10·075632	11 15	9·924368	38	30
51	24	9·734353	12 39	10·265647	9·810025	12 55	10·189975	10·075672	12 16	9·924328	36	9
30	26	9·734451	13 42	10·265549	9·810164	13 60	10·189836	10·075713	13 18	9·924287	34	30
52	28	9·734549	14 46	10·265451	9·810302	14 65	10·189698	10·075754	14 19	9·924246	32	8
30	30	9·734646	15 49	10·265354	9·810441	15 69	10·189559	10·075795	15 20	9·924205	30	30
53	32	9·734744	16 52	10·265256	9·810580	16 74	10·189420	10·075836	16 22	9·924164	28	7
30	34	9·734842	17 55	10·265158	9·810718	17 79	10·189282	10·075876	17 23	9·924124	26	30
54	36	9·734939	18 59	10·265061	9·810857	18 83	10·189143	10·075917	18 24	9·924083	24	6
30	38	9·735037	19 62	10·264963	9·810995	19 88	10·189005	10·075958	19 26	9·924042	22	30
55	40	9·735135	20 65	10·264865	9·811134	20 92	10·188866	10·075999	20 27	9·924001	20	5
30	42	9·735232	21 68	10·264768	9·811272	21 97	10·188728	10·076040	21 29	9·923960	18	30
56	44	9·735330	22 72	10·264670	9·811410	22 102	10·188590	10·076081	22 30	9·923919	16	4
30	46	9·735427	23 75	10·264573	9·811549	23 106	10·188451	10·076122	23 31	9·923878	14	30
57	48	9·735525	24 78	10·264475	9·811687	24 111	10·188313	10·076163	24 33	9·923837	12	3
30	50	9·735622	25 82	10·264378	9·811826	25 116	10·188174	10·076204	25 34	9·923796	10	30
58	52	9·735719	26 85	10·264281	9·811964	26 120	10·188036	10·076245	26 35	9·923755	8	2
30	4	9·735817	27 88	10·264183	9·812102	27 125	10·187898	10·076286	27 37	9·923714	6	30
59	56	9·735914	28 91	10·264086	9·812241	28 129	10·187759	10·076327	28 38	9·923673	4	1
30	58	9·736011	29 95	10·263989	9·812379	29 134	10·187621	10·076368	29 39	9·923632	2	30
60	**12**	9·736109	30 98	10·263891	9·812517	30 139	10·187483	10·076409	30 41	9·923591	0	0
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

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LOG. SINES, COSINES, &c.

2^h 12^m 33°

″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	″
0	0	9·736109		10·263891	9·812517		10·187483	10·076409		9·923591	48	60
30	2	9·736206	1″ 3	10·263794	9·812656	1″ 5	10·187344	10·076450	1″ 1	9·923550	58	30
1	4	9·736303	2 6	10·263697	9·812794	2 9	10·187206	10·076491	2 3	9·923509	56	59
30	6	9·736400	3 10	10·263600	9·812932	3 14	10·187068	10·076532	3 4	9·923468	54	30
2	8	9·736498	4 13	10·263502	9·813070	4 18	10·186930	10·076573	4 5	9·923427	52	58
30	10	9·736595	5 16	10·263405	9·813209	5 23	10·186791	10·076614	5 7	9·923386	50	30
3	12	9·736692	6 19	10·263308	9·813347	6 28	10·186653	10·076655	6 8	9·923345	48	57
30	14	9·736789	7 23	10·263211	9·813485	7 32	10·186515	10·076696	7 10	9·923304	46	30
4	16	9·736886	8 26	10·263114	9·813623	8 37	10·186377	10·076737	8 11	9·923263	44	56
30	18	9·736983	9 29	10·263017	9·813761	9 41	10·186239	10·076778	9 12	9·923222	42	30
5	20	9·737080	10 32	10·262920	9·813899	10 46	10·186101	10·076819	10 14	9·923181	40	55
30	22	9·737177	11 36	10·262823	9·814037	11 51	10·185963	10·076861	11 15	9·923139	38	30
6	24	9·737274	12 39	10·262726	9·814176	12 55	10·185824	10·076902	12 17	9·923098	36	54
30	26	9·737371	13 42	10·262629	9·814314	13 60	10·185686	10·076943	13 18	9·923057	34	30
7	28	9·737467	14 45	10·262533	9·814452	14 64	10·185548	10·076984	14 19	9·923016	32	53
30	30	9·737564	15 48	10·262436	9·814590	15 69	10·185410	10·077025	15 21	9·922975	30	30
8	32	9·737661	16 51	10·262339	9·814728	16 74	10·185272	10·077067	16 22	9·922933	28	52
30	34	9·737758	17 55	10·262242	9·814866	17 78	10·185134	10·077108	17 23	9·922892	26	30
9	36	9·737855	18 58	10·262145	9·815004	18 83	10·184996	10·077149	18 25	9·922851	24	51
30	38	9·737951	19 61	10·262049	9·815142	19 87	10·184858	10·077190	19 26	9·922810	22	30
10	40	9·738048	20 64	10·261952	9·815280	20 92	10·184720	10·077232	20 27	9·922768	20	50
30	42	9·738145	21 68	10·261855	9·815417	21 97	10·184583	10·077273	21 29	9·922727	18	30
11	44	9·738241	22 71	10·261759	9·815555	22 101	10·184445	10·077314	22 30	9·922686	16	49
30	46	9·738338	23 74	10·261662	9·815693	23 106	10·184307	10·077356	23 32	9·922644	14	30
12	48	9·738434	24 77	10·261566	9·815831	24 110	10·184169	10·077397	24 33	9·922603	12	48
30	50	9·738531	25 81	10·261469	9·815969	25 115	10·184031	10·077438	25 34	9·922562	10	30
13	52	9·738627	26 84	10·261373	9·816107	26 120	10·183893	10·077480	26 36	9·922520	8	47
30	54	9·738724	27 87	10·261276	9·816245	27 124	10·183755	10·077521	27 37	9·922479	6	30
14	56	9·738820	28 90	10·261180	9·816382	28 129	10·183618	10·077562	28 38	9·922438	4	46
30	58	9·738917	29 94	10·261083	9·816520	29 133	10·183480	10·077604	29 40	9·922396	2	30
15	13	9·739013	30 97	10·260987	9·816658	30 138	10·183342	10·077645	30 41	9·922355	47	45
30	2	9·739109	1 3	10·260891	9·816796	1 5	10·183204	10·077687	1 1	9·922313	58	30
16	4	9·739206	2 6	10·260794	9·816933	2 9	10·183067	10·077728	2 3	9·922272	56	44
30	6	9·739302	3 10	10·260698	9·817071	3 14	10·182929	10·077769	3 4	9·922231	54	30
17	8	9·739398	4 13	10·260602	9·817209	4 18	10·182791	10·077811	4 6	9·922189	52	43
30	10	9·739494	5 16	10·260506	9·817347	5 23	10·182653	10·077852	5 7	9·922148	50	30
18	12	9·739590	6 19	10·260410	9·817484	6 27	10·182516	10·077894	6 8	9·922106	48	42
30	14	9·739687	7 22	10·260313	9·817622	7 32	10·182378	10·077935	7 10	9·922065	46	30
19	16	9·739783	8 26	10·260217	9·817759	8 37	10·182241	10·077977	8 11	9·922023	44	41
30	18	9·739879	9 29	10·260121	9·817897	9 41	10·182103	10·078018	9 13	9·921982	42	30
20	20	9·739975	10 32	10·260025	9·818035	10 46	10·181965	10·078060	10 14	9·921940	40	40
30	22	9·740071	11 35	10·259929	9·818172	11 50	10·181828	10·078101	11 15	9·921899	38	30
21	24	9·740167	12 38	10·259833	9·818310	12 55	10·181690	10·078143	12 17	9·921857	36	39
30	26	9·740263	13 42	10·259737	9·818447	13 60	10·181553	10·078185	13 18	9·921815	34	30
22	28	9·740359	14 45	10·259641	9·818585	14 64	10·181415	10·078226	14 19	9·921774	32	38
30	30	9·740455	15 48	10·259545	9·818722	15 69	10·181278	10·078268	15 21	9·921732	30	30
23	32	9·740550	16 51	10·259450	9·818860	16 73	10·181140	10·078309	16 22	9·921691	28	37
30	34	9·740646	17 54	10·259354	9·818997	17 78	10·181003	10·078351	17 24	9·921649	26	30
24	36	9·740742	18 57	10·259258	9·819135	18 82	10·180865	10·078393	18 25	9·921607	24	36
30	38	9·740838	19 61	10·259162	9·819272	19 87	10·180728	10·078434	19 26	9·921566	22	30
25	40	9·740934	20 64	10·259066	9·819410	20 92	10·180590	10·078476	20 28	9·921524	20	35
30	42	9·741029	21 67	10·258971	9·819547	21 96	10·180453	10·078518	21 29	9·921482	18	30
26	44	9·741125	22 70	10·258875	9·819684	22 101	10·180316	10·078559	22 31	9·921441	16	34
30	46	9·741221	23 74	10·258779	9·819822	23 105	10·180178	10·078601	23 32	9·921399	14	30
27	48	9·741316	24 77	10·258684	9·819959	24 110	10·180041	10·078643	24 33	9·921357	12	33
30	50	9·741412	25 80	10·258588	9·820096	25 114	10·179904	10·078685	25 35	9·921315	10	30
28	52	9·741508	26 83	10·258492	9·820234	26 119	10·179766	10·078726	26 36	9·921274	8	32
30	54	9·741603	27 86	10·258397	9·820371	27 124	10·179629	10·078768	27 38	9·921232	6	30
29	56	9·741699	28 89	10·258301	9·820508	28 128	10·179492	10·078810	28 39	9·921190	4	31
30	58	9·741794	29 93	10·258206	9·820646	29 133	10·179354	10·078852	29 40	9·921148	2	30
30	14	9·741889	30 96	10·258111	9·820783	30 137	10·179217	10·078893	30 42	9·921107	0	30
″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	″

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2ʰ 14ᵐ — 33°

′ ″	m. s	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s	′ ″
30	0	9·741889		10·258111	9·820783		10·179217	10·078893		9·921107	**46**	30
30	2	9·741985	1″ 3	10·258015	9·820920	1″ 5	10·179080	10·078935	1″ 1	9·921065	58	30
31	4	9·742080	2 6	10·257920	9·821057	2 9	10·178943	10·078977	2 3	9·921023	56	29
30	6	9·742176	3 9	10·257824	9·821195	3 14	10·178805	10·079019	3 4	9·920981	54	30
32	8	9·742271	4 13	10·257729	9·821332	4 18	10·178668	10·079061	4 6	9·920939	52	28
30	10	9·742366	5 16	10·257634	9·821469	5 23	10·178531	10·079103	5 7	9·920897	50	30
33	12	9·742462	6 19	10·257538	9·821606	6 27	10·178394	10·079144	6 8	9·920856	48	27
30	14	9·742557	7 22	10·257443	9·821743	7 32	10·178257	10·079186	7 10	9·920814	46	30
34	16	9·742652	8 25	10·257348	9·821880	8 37	10·178120	10·079228	8 11	9·920772	44	26
30	18	9·742747	9 28	10·257253	9·822017	9 41	10·177983	10·079270	9 13	9·920730	42	30
35	20	9·742842	10 32	10·257158	9·822154	10 46	10·177846	10·079312	10 14	9·920688	40	25
30	22	9·742937	11 35	10·257063	9·822292	11 50	10·177708	10·079354	11 15	9·920646	38	30
36	24	9·743033	12 38	10·256967	9·822429	12 55	10·177571	10·079396	12 17	9·920604	36	24
30	26	9·743128	13 41	10·256872	9·822566	13 59	10·177434	10·079438	13 18	9·920562	34	30
37	28	9·743223	14 44	10·256777	9·822703	14 64	10·177297	10·079480	14 20	9·920520	32	23
30	30	9·743318	15 48	10·256682	9·822840	15 69	10·177160	10·079522	15 21	9·920478	30	30
38	32	9·743413	16 51	10·256587	9·822977	16 73	10·177023	10·079564	16 22	9·920436	28	22
30	34	9·743508	17 54	10·256492	9·823114	17 78	10·176886	10·079606	17 24	9·920394	26	30
39	36	9·743602	18 57	10·256398	9·823251	18 82	10·176749	10·079648	18 25	9·920352	24	21
30	38	9·743697	19 60	10·256303	9·823387	19 87	10·176613	10·079690	19 27	9·920310	22	30
40	40	9·743792	20 63	10·256208	9·823524	20 91	10·176476	10·079732	20 28	9·920268	20	20
30	42	9·743887	21 67	10·256113	9·823661	21 96	10·176339	10·079774	21 29	9·920226	18	30
41	44	9·743982	22 70	10·256018	9·823798	22 101	10·176202	10·079816	22 31	9·920184	16	19
30	46	9·744077	23 73	10·255923	9·823935	23 105	10·176065	10·079859	23 32	9·920141	14	30
42	48	9·744171	24 76	10·255829	9·824072	24 110	10·175928	10·079901	24 34	9·920099	12	18
30	50	9·744266	25 79	10·255734	9·824209	25 114	10·175791	10·079943	25 35	9·920057	10	30
43	52	9·744361	26 82	10·255639	9·824345	26 119	10·175655	10·079985	26 36	9·920015	8	17
30	54	9·744455	27 86	10·255545	9·824482	27 123	10·175518	10·080027	27 38	9·919973	6	30
44	56	9·744550	28 89	10·255450	9·824619	28 128	10·175381	10·080069	28 39	9·919931	4	16
30	58	9·744644	29 92	10·255356	9·824756	29 133	10·175244	10·080111	29 41	9·919889	2	30
45	**15**	9·744739	30 95	10·255261	9·824893	30 137	10·175107	10·080154	30 42	9·919846	**45**	15
30	2	9·744833	1 3	10·255167	9·825029	1 5	10·174971	10·080196	1 1	9·919804	58	30
46	4	9·744928	2 6	10·255072	9·825166	2 9	10·174834	10·080238	2 3	9·919762	56	14
30	6	9·745022	3 9	10·254978	9·825303	3 14	10·174697	10·080280	3 4	9·919720	54	30
47	8	9·745117	4 13	10·254883	9·825439	4 18	10·174561	10·080323	4 6	9·919677	52	13
30	10	9·745211	5 16	10·254789	9·825576	5 23	10·174424	10·080365	5 7	9·919635	50	30
48	12	9·745306	6 19	10·254694	9·825713	6 27	10·174287	10·080407	6 8	9·919593	48	12
30	14	9·745400	7 22	10·254600	9·825849	7 32	10·174151	10·080449	7 10	9·919551	46	30
49	16	9·745494	8 25	10·254506	9·825986	8 36	10·174014	10·080492	8 11	9·919508	44	11
30	18	9·745589	9 28	10·254411	9·826123	9 41	10·173877	10·080534	9 13	9·919466	42	30
50	20	9·745683	10 31	10·254317	9·826259	10 45	10·173741	10·080576	10 14	9·919424	40	10
30	22	9·745777	11 35	10·254223	9·826396	11 50	10·173604	10·080619	11 16	9·919381	38	30
51	24	9·745871	12 38	10·254129	9·826532	12 55	10·173468	10·080661	12 17	9·919339	36	9
30	26	9·745965	13 41	10·254035	9·826669	13 59	10·173331	10·080703	13 18	9·919297	34	30
52	28	9·746060	14 44	10·253940	9·826805	14 64	10·173195	10·080746	14 20	9·919254	32	8
30	30	9·746154	15 47	10·253846	9·826942	15 68	10·173058	10·080788	15 21	9·919212	30	30
53	32	9·746248	16 50	10·253752	9·827078	16 73	10·172922	10·080831	16 23	9·919169	28	7
30	34	9·746342	17 53	10·253658	9·827215	17 77	10·172785	10·080873	17 24	9·919127	26	30
54	36	9·746436	18 56	10·253564	9·827351	18 82	10·172649	10·080915	18 25	9·919085	24	6
30	38	9·746530	19 60	10·253470	9·827488	19 86	10·172512	10·080958	19 27	9·919042	22	30
55	40	9·746624	20 63	10·253376	9·827624	20 91	10·172376	10·081000	20 28	9·919000	20	5
30	42	9·746718	21 66	10·253282	9·827761	21 96	10·172239	10·081043	21 30	9·918957	18	30
56	44	9·746812	22 69	10·253188	9·827897	22 100	10·172103	10·081085	22 31	9·918915	16	4
30	46	9·746905	23 72	10·253095	9·828033	23 105	10·171967	10·081128	23 32	9·918872	14	30
57	48	9·746999	24 75	10·253001	9·828170	24 109	10·171830	10·081170	24 34	9·918830	12	3
30	50	9·747093	25 79	10·252907	9·828306	25 114	10·171694	10·081213	25 35	9·918787	10	30
58	52	9·747187	26 82	10·252813	9·828442	26 118	10·171558	10·081255	26 37	9·918745	8	2
30	54	9·747281	27 85	10·252719	9·828579	27 123	10·171421	10·081298	27 38	9·918702	6	30
59	56	9·747374	28 88	10·252626	9·828715	28 127	10·171285	10·081341	28 39	9·918659	4	1
30	58	9·747468	29 91	10·252532	9·828851	29 132	10·171149	10·081383	29 41	9·918617	2	30
60	**16**	9·747562	30 94	10·252438	9·828987	30 136	10·171013	10·081426	30 42	9·918574	0	0
′ ″	m. s	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s	′ ″

56° — 3ʰ 44ᵐ

LOG. SINES, COSINES, &c.

2ʰ 16ᵐ | 34°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·747562		10·252438	9·828987		10·171013	10·081426		9·918574	44	60
30	2	9·747655	1″ 3	10·252345	9·829124	1″ 5	10·170876	10·081468	1″ 1	9·918532	58	30
1	4	9·747749	2 6	10·252251	9·829260	2 9	10·170740	10·081511	2 3	9·918489	56	59
30	6	9·747842	3 9	10·252158	9·829396	3 14	10·170604	10·081554	3 4	9·918446	54	30
2	8	9·747936	4 12	10·252064	9·829532	4 18	10·170468	10·081596	4 6	9·918404	52	58
30	10	9·748030	5 16	10·251970	9·829669	5 23	10·170331	10·081639	5 7	9·918361	50	30
3	12	9·748123	6 19	10·251877	9·829805	6 27	10·170195	10·081682	6 9	9·918318	48	57
30	14	9·748216	7 22	10·251784	9·829941	7 32	10·170059	10·081724	7 10	9·918276	46	30
4	16	9·748310	8 25	10·251690	9·830077	8 36	10·169923	10·081767	8 11	9·918233	44	56
30	18	9·748403	9 28	10·251597	9·830213	9 41	10·169787	10·081810	9 13	9·918190	42	30
5	20	9·748497	10 31	10·251503	9·830349	10 45	10·169651	10·081853	10 14	9·918147	40	55
30	22	9·748590	11 34	10·251410	9·830485	11 50	10·169515	10·081895	11 16	9·918105	38	30
6	24	9·748683	12 37	10·251317	9·830621	12 54	10·169379	10·081938	12 17	9·918062	36	54
30	26	9·748777	13 40	10·251223	9·830757	13 59	10·169243	10·081981	13 19	9·918019	34	30
7	28	9·748870	14 43	10·251130	9·830893	14 63	10·169107	10·082024	14 20	9·917976	32	53
30	30	9·748963	15 47	10·251037	9·831029	15 68	10·168971	10·082066	15 21	9·917934	30	30
8	32	9·749056	16 50	10·250944	9·831165	16 72	10·168835	10·082109	16 23	9·917891	28	52
30	34	9·749149	17 53	10·250851	9·831301	17 77	10·168699	10·082152	17 24	9·917848	26	30
9	36	9·749243	18 56	10·250757	9·831437	18 82	10·168563	10·082195	18 26	9·917805	24	51
30	38	9·749336	19 59	10·250664	9·831573	19 86	10·168427	10·082238	19 27	9·917762	22	30
10	40	9·749429	20 62	10·250571	9·831709	20 91	10·168291	10·082281	20 29	9·917719	20	50
30	42	9·749522	21 65	10·250478	9·831845	21 95	10·168155	10·082324	21 30	9·917677	18	30
11	44	9·749615	22 68	10·250385	9·831981	22 100	10·168019	10·082366	22 31	9·917634	16	49
30	46	9·749708	23 72	10·250292	9·832117	23 104	10·167883	10·082409	23 33	9·917591	14	30
12	48	9·749801	24 75	10·250199	9·832253	24 109	10·167747	10·082452	24 34	9·917548	12	48
30	50	9·749894	25 78	10·250106	9·832389	25 113	10·167611	10·082495	25 36	9·917505	10	30
13	52	9·749987	26 81	10·250013	9·832525	26 118	10·167475	10·082538	26 37	9·917462	8	47
30	54	9·750079	27 84	10·249921	9·832660	27 122	10·167340	10·082581	27 39	9·917419	6	30
14	56	9·750172	28 87	10·249828	9·832796	28 127	10·167204	10·082624	28 40	9·917376	4	46
30	58	9·750265	29 90	10·249735	9·832932	29 131	10·167068	10·082667	29 41	9·917333	2	30
15	17	9·750358	30 93	10·249642	9·833068	30 136	10·166932	10·082710	30 43	9·917290	43	45
30	2	9·750451	1 3	10·249549	9·833204	1 5	10·166796	10·082753	1 1	9·917247	58	30
16	4	9·750543	2 6	10·249457	9·833339	2 9	10·166661	10·082796	2 3	9·917204	56	44
30	6	9·750636	3 9	10·249364	9·833475	3 14	10·166525	10·082839	3 4	9·917161	54	30
17	8	9·750729	4 12	10·249271	9·833611	4 18	10·166389	10·082882	4 6	9·917118	52	43
30	10	9·750821	5 15	10·249179	9·833747	5 23	10·166253	10·082925	5 7	9·917075	50	30
18	12	9·750914	6 18	10·249086	9·833882	6 27	10·166118	10·082968	6 9	9·917032	48	42
30	14	9·751007	7 21	10·248993	9·834018	7 32	10·165982	10·083011	7 10	9·916989	46	30
19	16	9·751099	8 25	10·248901	9·834154	8 36	10·165846	10·083054	8 12	9·916946	44	41
30	18	9·751192	9 28	10·248808	9·834289	9 41	10·165711	10·083098	9 13	9·916902	42	30
20	20	9·751284	10 31	10·248716	9·834425	10 45	10·165575	10·083141	10 14	9·916859	40	40
30	22	9·751377	11 34	10·248623	9·834561	11 50	10·165440	10·083184	11 16	9·916816	38	30
21	24	9·751469	12 37	10·248531	9·834696	12 54	10·165304	10·083227	12 17	9·916773	36	39
30	26	9·751561	13 40	10·248439	9·834832	13 59	10·165168	10·083270	13 19	9·916730	34	30
22	28	9·751654	14 43	10·248346	9·834967	14 63	10·165033	10·083313	14 20	9·916687	32	38
30	30	9·751746	15 46	10·248254	9·835103	15 68	10·164897	10·083357	15 22	9·916643	30	30
23	32	9·751839	16 49	10·248161	9·835238	16 72	10·164762	10·083400	16 23	9·916600	28	37
30	34	9·751931	17 52	10·248069	9·835374	17 77	10·164626	10·083443	17 24	9·916557	26	30
24	36	9·752023	18 55	10·247977	9·835509	18 81	10·164491	10·083486	18 26	9·916514	24	36
30	38	9·752115	19 59	10·247885	9·835645	19 86	10·164355	10·083530	19 27	9·916470	22	30
25	40	9·752208	20 62	10·247792	9·835780	20 90	10·164220	10·083573	20 29	9·916427	20	35
30	42	9·752300	21 65	10·247700	9·835916	21 95	10·164084	10·083616	21 30	9·916384	18	30
26	44	9·752392	22 68	10·247608	9·836051	22 99	10·163949	10·083659	22 32	9·916341	16	34
30	46	9·752484	23 71	10·247516	9·836187	23 104	10·163813	10·083703	23 33	9·916297	14	30
27	48	9·752576	24 74	10·247424	9·836322	24 108	10·163678	10·083746	24 35	9·916254	12	33
30	50	9·752668	25 77	10·247332	9·836458	25 113	10·163542	10·083789	25 36	9·916211	10	30
28	52	9·752760	26 80	10·247240	9·836593	26 118	10·163407	10·083833	26 37	9·916167	8	32
30	54	9·752852	27 83	10·247148	9·836728	27 122	10·163272	10·083876	27 39	9·916124	6	30
29	56	9·752944	28 86	10·247056	9·836864	28 127	10·163136	10·083920	28 40	9·916081	4	31
30	58	9·753036	29 89	10·246964	9·836999	29 131	10·163001	10·083963	29 42	9·916037	2	30
30	18	9·753128	30 92	10·246872	9·837134	30 136	10·162866	10·084006	30 43	9·915994	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

55° | 3ʰ 42ᵐ

LOG. SINES, COSINES, &c.

2h 18m — 34°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
30	0	9·753128		10·246872	9·837134		10·162866	10·084006		9·915994	42	30
30	2	9·753220	1″ 3	10·246780	9·837270	1″ 4	10·162730	10·084050	1″ 1	9·915950	58	30
31	4	9·753312	2 6	10·246688	9·837405	2 9	10·162595	10·084093	2 3	9·915907	56	29
30	6	9·753404	3 9	10·246596	9·837540	3 13	10·162460	10·084137	3 4	9·915863	54	30
32	8	9·753495	4 12	10·246505	9·837675	4 18	10·162325	10·084180	4 6	9·915820	52	28
30	10	9·753587	5 15	10·246413	9·837811	5 22	10·162189	10·084224	5 7	9·915776	50	30
33	12	9·753679	6 18	10·246321	9·837946	6 27	10·162054	10·084267	6 9	9·915733	48	27
30	14	9·753771	7 21	10·246229	9·838081	7 31	10·161919	10·084311	7 10	9·915689	46	30
34	16	9·753862	8 24	10·246138	9·838216	8 36	10·161784	10·084354	8 12	9·915646	44	26
30	18	9·753954	9 27	10·246046	9·838352	9 40	10·161648	10·084398	9 13	9·915602	42	30
35	20	9·754046	10 30	10·245954	9·838487	10 45	10·161513	10·084441	10 15	9·915559	40	25
30	22	9·754137	11 34	10·245863	9·838622	11 49	10·161378	10·084485	11 16	9·915515	38	30
36	24	9·754229	12 37	10·245771	9·838757	12 54	10·161243	10·084528	12 17	9·915472	36	24
30	26	9·754320	13 40	10·245680	9·838892	13 58	10·161108	10·084572	13 19	9·915428	34	30
37	28	9·754412	14 43	10·245588	9·839027	14 63	10·160973	10·084615	14 20	9·915385	32	23
30	30	9·754503	15 46	10·245497	9·839162	15 67	10·160838	10·084659	15 22	9·915341	30	30
38	32	9·754595	16 49	10·245405	9·839297	16 72	10·160703	10·084703	16 23	9·915297	28	22
30	34	9·754686	17 52	10·245314	9·839433	17 76	10·160567	10·084746	17 25	9·915254	26	30
39	36	9·754778	18 55	10·245222	9·839568	18 81	10·160432	10·084790	18 26	9·915210	24	21
30	38	9·754869	19 58	10·245131	9·839703	19 85	10·160297	10·084834	19 28	9·915166	22	30
40	40	9·754960	20 61	10·245040	9·839838	20 90	10·160162	10·084877	20 29	9·915123	20	20
30	42	9·755052	21 64	10·244948	9·839973	21 94	10·160027	10·084921	21 30	9·915079	18	30
41	44	9·755143	22 67	10·244857	9·840108	22 99	10·159892	10·084965	22 32	9·915035	16	19
30	46	9·755234	23 70	10·244766	9·840243	23 103	10·159757	10·085008	23 33	9·914992	14	20
42	48	9·755326	24 73	10·244674	9·840378	24 108	10·159622	10·085052	24 35	9·914948	12	18
30	50	9·755417	25 76	10·244583	9·840513	25 112	10·159487	10·085096	25 36	9·914904	10	30
43	52	9·755508	26 79	10·244492	9·840648	26 117	10·159352	10·085140	26 38	9·914860	8	17
30	54	9·755599	27 82	10·244401	9·840782	27 121	10·159218	10·085183	27 39	9·914817	6	30
44	56	9·755690	28 85	10·244310	9·840917	28 126	10·159083	10·085227	28 40	9·914773	4	16
30	58	9·755781	29 88	10·244219	9·841052	29 130	10·158948	10·085271	29 42	9·914729	2	30
45	**19**	9·755872	30 91	10·244128	9·841187	30 135	10·158813	10·085315	30 44	9·914685	**41**	15
30	2	9·755963	1 3	10·244037	9·841322	1 4	10·158678	10·085359	1 1	9·914641	58	30
16	4	9·756054	2 6	10·243946	9·841457	2 9	10·158543	10·085402	2 3	9·914598	56	14
30	6	9·756145	3 9	10·243855	9·841592	3 13	10·158408	10·085446	3 4	9·914554	54	30
47	8	9·756236	4 12	10·243764	9·841727	4 18	10·158273	10·085490	4 6	9·914510	52	13
30	10	9·756327	5 15	10·243673	9·841861	5 22	10·158139	10·085534	5 7	9·914466	50	30
48	12	9·756418	6 18	10·243582	9·841996	6 27	10·158004	10·085578	6 9	9·914422	48	12
30	14	9·756509	7 21	10·243491	9·842131	7 31	10·157869	10·085622	7 10	9·914378	46	30
49	16	9·756600	8 24	10·243400	9·842266	8 36	10·157734	10·085666	8 12	9·914334	44	11
30	18	9·756691	9 27	10·243309	9·842400	9 40	10·157600	10·085710	9 13	9·914290	42	30
50	20	9·756782	10 30	10·243218	9·842535	10 45	10·157465	10·085754	10 15	9·914246	40	10
30	22	9·756872	11 33	10·243128	9·842670	11 49	10·157330	10·085798	11 16	9·914202	38	30
51	24	9·756963	12 36	10·243037	9·842805	12 54	10·157195	10·085842	12 18	9·914158	36	9
30	26	9·757054	13 39	10·242946	9·842939	13 58	10·157061	10·085886	13 19	9·914114	34	30
52	28	9·757144	14 42	10·242856	9·843074	14 63	10·156926	10·085930	14 21	9·914070	32	8
30	30	9·757235	15 45	10·242765	9·843209	15 67	10·156791	10·085974	15 21	9·914026	30	30
53	32	9·757326	16 48	10·242674	9·843343	16 72	10·156657	10·086018	16 24	9·913982	28	7
30	34	9·757416	17 51	10·242584	9·843478	17 76	10·156522	10·086062	17 25	9·913938	26	30
54	36	9·757507	18 54	10·242493	9·843612	18 81	10·156388	10·086106	18 26	9·913894	24	6
30	38	9·757597	19 57	10·242403	9·843747	19 85	10·156253	10·086150	19 28	9·913850	22	30
55	40	9·757688	20 60	10·242312	9·843882	20 90	10·156118	10·086194	20 29	9·913806	20	5
30	42	9·757778	21 63	10·242222	9·844016	21 94	10·155984	10·086238	21 31	9·913762	18	30
56	44	9·757869	22 66	10·242131	9·844151	22 99	10·155849	10·086282	22 32	9·913718	16	4
30	46	9·757959	23 69	10·242041	9·844285	23 103	10·155715	10·086326	23 34	9·913674	14	30
57	48	9·758050	24 72	10·241950	9·844420	24 108	10·155580	10·086370	24 35	9·913630	12	3
30	50	9·758140	25 76	10·241860	9·844554	25 112	10·155446	10·086415	25 37	9·913585	10	30
58	52	9·758230	26 79	10·241770	9·844689	26 117	10·155311	10·086459	26 38	9·913541	8	2
30	54	9·758321	27 82	10·241679	9·844823	27 121	10·155177	10·086503	27 40	9·913497	6	30
59	56	9·758411	28 85	10·241589	9·844958	28 126	10·155042	10·086547	28 41	9·913453	4	1
30	58	9·758501	29 88	10·241499	9·845092	29 130	10·154908	10·086591	29 43	9·913409	2	30
60	**20**	9·758591	30 91	10·241409	9·845227	30 135	10·154773	10·086635	30 44	9·913365	0	0
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

55° — 3h 40m

LOG. SINES, COSINES, &c.

2h 20m — 35°

″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang	Secant	Parts	Cosine	m.	″
0	0	9·758591		10·241409	9·845227		10·154773	10·086635		9·913365	40	60
30	2	9·758681	1″ 3	10·241319	9·845361	1″ 4	10·154639	10·086680	1″ 1	9·913320	58	30
1	4	9·758772	2 6	10·241228	9·845496	2 9	10·154504	10·086724	2 3	9·913276	56	59
30	6	9·758862	3 9	10·241138	9·845630	3 13	10·154370	10·086768	3 4	9·913232	54	30
2	8	9·758952	4 12	10·241048	9·845764	4 18	10·154236	10·086813	4 6	9·913187	52	58
30	10	9·759042	5 15	10·240958	9·845899	5 22	10·154101	10·086857	5 7	9·913143	50	30
3	12	9·759132	6 18	10·240868	9·846033	6 27	10·153967	10·086901	6 9	9·913099	48	57
30	14	9·759222	7 21	10·240778	9·846168	7 31	10·153832	10·086945	7 10	9·913055	46	30
4	16	9·759312	8 24	10·240688	9·846302	8 36	10·153698	10·086990	8 12	9·913010	44	56
30	18	9·759402	9 27	10·240598	9·846436	9 40	10·153564	10·087034	9 13	9·912966	42	30
5	20	9·759492	10 30	10·240508	9·846570	10 45	10·153430	10·087078	10 15	9·912922	40	55
30	22	9·759582	11 33	10·240418	9·846705	11 49	10·153295	10·087123	11 16	9·912877	38	30
6	24	9·759672	12 36	10·240328	9·846839	12 54	10·153161	10·087167	12 18	9·912833	36	54
30	26	9·759762	13 39	10·240238	9·846973	13 58	10·153027	10·087212	13 19	9·912788	34	30
7	28	9·759852	14 42	10·240148	9·847108	14 63	10·152892	10·087256	14 21	9·912744	32	53
30	30	9·759941	15 45	10·240059	9·847242	15 67	10·152758	10·087300	15 22	9·912700	30	30
8	32	9·760031	16 48	10·239969	9·847376	16 72	10·152624	10·087345	16 24	9·912655	28	52
30	34	9·760121	17 51	10·239879	9·847510	17 76	10·152490	10·087389	17 25	9·912611	26	30
9	36	9·760211	18 54	10·239789	9·847644	18 80	10·152356	10·087434	18 27	9·912566	24	51
30	38	9·760300	19 57	10·239700	9·847779	19 85	10·152221	10·087478	19 28	9·912522	22	30
10	40	9·760390	20 60	10·239610	9·847913	20 89	10·152087	10·087523	20 30	9·912477	20	50
30	42	9·760480	21 63	10·239520	9·848047	21 94	10·151953	10·087567	21 31	9·912433	18	30
11	44	9·760569	22 66	10·239431	9·848181	22 98	10·151819	10·087612	22 33	9·912388	16	49
30	46	9·760659	23 69	10·239341	9·848315	23 103	10·151685	10·087656	23 34	9·912344	14	30
12	48	9·760748	24 72	10·239252	9·848449	24 107	10·151551	10·087701	24 36	9·912299	12	48
30	50	9·760838	25 75	10·239162	9·848583	25 112	10·151417	10·087746	25 37	9·912255	10	30
13	52	9·760927	26 78	10·239073	9·848717	26 116	10·151283	10·087790	26 38	9·912210	8	47
30	54	9·761017	27 81	10·238983	9·848851	27 121	10·151149	10·087835	27 40	9·912165	6	30
14	56	9·761106	28 84	10·238894	9·848986	28 125	10·151014	10·087879	28 41	9·912121	4	46
30	58	9·761196	29 87	10·238804	9·849120	29 130	10·150880	10·087924	29 43	9·912076	2	30
15	21	9·761285	30 90	10·238715	9·849254	30 134	10·150746	10·087969	30 44	9·912031	39	45
30	2	9·761374	1 3	10·238626	9·849388	1 4	10·150612	10·088013	1 1	9·911987	58	30
16	4	9·761464	2 6	10·238536	9·849522	2 9	10·150478	10·088058	2 3	9·911942	56	44
30	6	9·761553	3 9	10·238447	9·849655	3 13	10·150344	10·088103	3 4	9·911897	54	30
17	8	9·761642	4 12	10·238358	9·849790	4 18	10·150210	10·088147	4 6	9·911853	52	43
30	10	9·761732	5 15	10·238268	9·849924	5 22	10·150076	10·088192	5 7	9·911808	50	30
18	12	9·761821	6 18	10·238179	9·850057	6 27	10·149943	10·088237	6 9	9·911763	48	42
30	14	9·761910	7 21	10·238090	9·850191	7 31	10·149809	10·088281	7 10	9·911719	46	30
19	16	9·761999	8 24	10·238001	9·850325	8 36	10·149675	10·088326	8 12	9·911674	44	41
30	18	9·762088	9 27	10·237912	9·850459	9 40	10·149541	10·088371	9 13	9·911629	42	30
20	20	9·762177	10 30	10·237823	9·850593	10 45	10·149407	10·088416	10 15	9·911584	40	40
30	22	9·762267	11 33	10·237733	9·850727	11 49	10·149273	10·088460	11 16	9·911540	38	30
21	24	9·762356	12 36	10·237644	9·850861	12 54	10·149139	10·088505	12 18	9·911495	36	39
30	26	9·762445	13 38	10·237555	9·850995	13 58	10·149005	10·088550	13 19	9·911450	34	30
22	28	9·762534	14 41	10·237466	9·851129	14 62	10·148871	10·088595	14 21	9·911405	32	38
30	30	9·762623	15 44	10·237377	9·851262	15 67	10·148738	10·088640	15 22	9·911360	30	30
23	32	9·762712	16 47	10·237288	9·851396	16 71	10·148604	10·088685	16 24	9·911315	28	37
30	34	9·762801	17 50	10·237199	9·851530	17 76	10·148470	10·088729	17 25	9·911271	26	30
24	36	9·762889	18 53	10·237111	9·851664	18 80	10·148336	10·088774	18 27	9·911226	24	36
30	38	9·762978	19 56	10·237022	9·851797	19 85	10·148203	10·088819	19 28	9·911181	22	30
25	40	9·763067	20 59	10·236933	9·851931	20 89	10·148069	10·088864	20 30	9·911136	20	35
30	42	9·763156	21 62	10·236844	9·852065	21 94	10·147935	10·088909	21 31	9·911091	18	30
26	44	9·763245	22 65	10·236755	9·852199	22 98	10·147801	10·088954	22 33	9·911046	16	34
30	46	9·763333	23 68	10·236667	9·852332	23 103	10·147668	10·088999	23 34	9·911001	14	30
27	48	9·763422	24 71	10·236578	9·852466	24 107	10·147534	10·089044	24 36	9·910956	12	33
30	50	9·763511	25 74	10·236489	9·852600	25 111	10·147400	10·089089	25 37	9·910911	10	30
28	52	9·763600	26 77	10·236400	9·852733	26 116	10·147267	10·089134	26 39	9·910866	8	32
30	54	9·763688	27 80	10·236312	9·852867	27 120	10·147133	10·089179	27 40	9·910821	6	30
29	56	9·763777	28 83	10·236223	9·853001	28 125	10·146999	10·089224	28 42	9·910776	4	31
30	58	9·763865	29 86	10·236135	9·853134	29 129	10·146866	10·089269	29 43	9·910731	2	30
30	22	9·763954	30 89	10·236046	9·853268	30 134	10·146732	10·089314	30 45	9·910686	0	30
″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	″

54° — 3h 38m

LOG. SINES, COSINES, &c.

2h 22m — 35°

″ ′	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	″ ′
30	0	9·763954		10·236046	9·853268		10·146732	10·089314		9·910686	38	30
30	2	9·764043	1″ 3	10·235957	9·853402	1″ 4	10·146598	10·089359	1″ 2	9·910641	58	30
31	4	9·764131	2 6	10·235869	9·853535	2 9	10·146465	10·089404	2 3	9·910596	56	29
30	6	9·764220	3 9	10·235780	9·853669	3 13	10·146331	10·089449	3 5	9·910551	54	30
32	8	9·764308	4 12	10·235692	9·853802	4 18	10·146198	10·089494	4 6	9·910506	52	28
30	10	9·764396	5 15	10·235604	9·853936	5 22	10·146064	10·089539	5 8	9·910461	50	30
33	12	9·764485	6 18	10·235515	9·854069	6 27	10·145931	10·089585	6 9	9·910415	48	27
30	14	9·764573	7 21	10·235427	9·854203	7 31	10·145797	10·089630	7 11	9·910370	46	30
34	16	9·764662	8 24	10·235338	9·854336	8 36	10·145664	10·089675	8 12	9·910325	44	26
30	18	9·764750	9 26	10·235250	9·854470	9 40	10·145530	10·089720	9 14	9·910280	42	30
35	20	9·764838	10 29	10·235162	9·854603	10 44	10·145397	10·089765	10 15	9·910235	40	25
30	22	9·764926	11 32	10·235074	9·854737	11 49	10·145263	10·089810	11 17	9·910190	38	30
36	24	9·765015	12 35	10·234985	9·854870	12 53	10·145130	10·089856	12 18	9·910144	36	24
30	26	9·765103	13 38	10·234897	9·855004	13 58	10·144996	10·089901	13 20	9·910099	34	30
37	28	9·765191	14 41	10·234809	9·855137	14 62	10·144863	10·089946	14 21	9·910054	32	23
30	30	9·765279	15 44	10·234721	9·855271	15 67	10·144729	10·089991	15 23	9·910009	30	30
38	32	9·765367	16 47	10·234633	9·855404	16 71	10·144596	10·090037	16 24	9·909963	28	22
30	34	9·765456	17 50	10·234544	9·855537	17 76	10·144463	10·090082	17 26	9·909918	26	30
39	36	9·765544	18 53	10·234456	9·855671	18 80	10·144329	10·090127	18 27	9·909873	24	21
30	38	9·765632	19 56	10·234368	9·855804	19 85	10·144196	10·090173	19 29	9·909827	22	30
40	40	9·765720	20 59	10·234280	9·855938	20 89	10·144062	10·090218	20 30	9·909782	20	20
30	42	9·765808	21 62	10·234192	9·856071	21 93	10·143929	10·090263	21 32	9·909737	18	30
41	44	9·765896	22 65	10·234104	9·856204	22 98	10·143796	10·090309	22 33	9·909691	16	19
30	46	9·765984	23 68	10·234016	9·856338	23 102	10·143662	10·090354	23 35	9·909646	14	30
42	48	9·766072	24 71	10·233928	9·856471	24 107	10·143529	10·090399	24 36	9·909601	12	18
30	50	9·766159	25 74	10·233841	9·856604	25 111	10·143396	10·090445	25 38	9·909555	10	30
43	52	9·766247	26 76	10·233753	9·856737	26 116	10·143263	10·090490	26 39	9·909510	8	17
30	54	9·766335	27 79	10·233665	9·856871	27 120	10·143129	10·090536	27 41	9·909464	6	30
44	56	9·766423	28 82	10·233577	9·857004	28 125	10·142996	10·090581	28 42	9·909419	4	16
30	58	9·766511	29 85	10·233489	9·857137	29 129	10·142863	10·090626	29 44	9·909374	2	30
45	23	9·766598	30 88	10·233402	9·857270	30 133	10·142730	10·090672	30 45	9·909328	37	15
30	2	9·766686	1 3	10·233314	9·857404	1 4	10·142596	10·090717	1 2	9·909283	58	30
46	4	9·766774	2 6	10·233226	9·857537	2 9	10·142463	10·090763	2 3	9·909237	56	14
30	6	9·766862	3 9	10·233138	9·857670	3 13	10·142330	10·090808	3 5	9·909192	54	30
47	8	9·766949	4 12	10·233051	9·857803	4 18	10·142197	10·090854	4 6	9·909146	52	13
30	10	9·767037	5 15	10·232963	9·857936	5 22	10·142064	10·090899	5 8	9·909101	50	30
48	12	9·767124	6 17	10·232876	9·858069	6 27	10·141931	10·090945	6 9	9·909055	48	12
30	14	9·767212	7 20	10·232788	9·858203	7 31	10·141797	10·090991	7 11	9·909009	46	30
49	16	9·767300	8 23	10·232700	9·858336	8 35	10·141664	10·091036	8 12	9·908964	44	11
30	18	9·767387	9 26	10·232613	9·858469	9 40	10·141531	10·091082	9 14	9·908918	42	30
50	20	9·767475	10 29	10·232525	9·858602	10 44	10·141398	10·091127	10 15	9·908873	40	10
30	22	9·767562	11 32	10·232438	9·858735	11 49	10·141265	10·091173	11 17	9·908827	38	30
51	24	9·767649	12 35	10·232351	9·858868	12 53	10·141132	10·091219	12 18	9·908781	36	9
30	26	9·767737	13 38	10·232263	9·859001	13 58	10·140999	10·091264	13 20	9·908736	34	30
52	28	9·767824	14 41	10·232176	9·859134	14 62	10·140866	10·091310	14 21	9·908690	32	8
30	30	9·767912	15 44	10·232088	9·859267	15 66	10·140733	10·091356	15 23	9·908644	30	30
53	32	9·767999	16 47	10·232001	9·859400	16 71	10·140600	10·091401	16 24	9·908599	28	7
30	34	9·768086	17 49	10·231914	9·859533	17 75	10·140467	10·091447	17 26	9·908553	26	30
54	36	9·768173	18 52	10·231827	9·859666	18 80	10·140334	10·091493	18 27	9·908507	24	6
30	38	9·768261	19 55	10·231739	9·859799	19 84	10·140201	10·091538	19 29	9·908462	22	30
55	40	9·768348	20 58	10·231652	9·859932	20 89	10·140068	10·091584	20 30	9·908416	20	5
30	42	9·768435	21 61	10·231565	9·860065	21 93	10·139935	10·091630	21 32	9·908370	18	30
56	44	9·768522	22 64	10·231478	9·860198	22 97	10·139802	10·091676	22 34	9·908324	16	4
30	46	9·768609	23 67	10·231391	9·860331	23 102	10·139669	10·091721	23 35	9·908279	14	30
57	48	9·768697	24 70	10·231303	9·860464	24 106	10·139536	10·091767	24 36	9·908233	12	3
30	50	9·768784	25 73	10·231216	9·860597	25 111	10·139403	10·091813	25 38	9·908187	10	30
58	52	9·768871	26 76	10·231129	9·860730	26 115	10·139270	10·091859	26 40	9·908141	8	2
30	54	9·768958	27 79	10·231042	9·860862	27 120	10·139138	10·091905	27 41	9·908095	6	30
59	56	9·769045	28 81	10·230955	9·860995	28 124	10·139005	10·091951	28 43	9·908049	4	1
30	58	9·769132	29 84	10·230868	9·861128	29 128	10·138872	10·091997	29 44	9·908003	2	30
60	24	9·769219	30 87	10·230781	9·861261	30 133	10·138739	10·092042	30 46	9·907958	0	0
″ ′	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	″ ′

54° — 3h 36m

LOG. SINES, COSINES, &c.

$2^h\ 24^m$ — 36°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·769219		10·230781	9·861261		10·138739	10·092042		9·907958	**36**	60
30	2	9·769306	1″ 3	10·230694	9·861394	1″ 4	10·138606	10·092088	1″ 2	9·907912	58	30
1	4	9·769393	2 6	10·230607	9·861527	2 9	10·138473	10·092134	2 3	9·907866	56	59
30	6	9·769479	3 9	10·230521	9·861659	3 13	10·138341	10·092180	3 5	9·907820	54	30
2	8	9·769566	4 12	10·230434	9·861792	4 18	10·138208	10·092226	4 6	9·907774	52	58
30	10	9·769653	5 14	10·230347	9·861925	5 22	10·138075	10·092272	5 8	9·907728	50	30
3	12	9·769740	6 17	10·230260	9·862058	6 27	10·137942	10·092318	6 9	9·907682	48	57
30	14	9·769827	7 20	10·230173	9·862191	7 31	10·137809	10·092364	7 11	9·907636	46	30
4	16	9·769913	8 23	10·230087	9·862323	8 35	10·137677	10·092410	8 12	9·907590	44	56
30	18	9·770000	9 26	10·230000	9·862456	9 40	10·137544	10·092456	9 14	9·907544	42	30
5	20	9·770087	10 29	10·229913	9·862589	10 44	10·137411	10·092502	10 15	9·907498	40	55
30	22	9·770173	11 32	10·229827	9·862721	11 49	10·137279	10·092548	11 17	9·907452	38	30
6	24	9·770260	12 35	10·229740	9·862854	12 53	10·137146	10·092594	12 18	9·907406	36	54
30	26	9·770347	13 37	10·229653	9·862987	13 57	10·137013	10·092640	13 20	9·907360	34	30
7	28	9·770433	14 40	10·229567	9·863119	14 62	10·136881	10·092686	14 21	9·907314	32	53
30	30	9·770520	15 43	10·229480	9·863252	15 66	10·136748	10·092732	15 23	9·907268	30	30
8	32	9·770606	16 46	10·229394	9·863385	16 71	10·136615	10·092778	16 25	9·907222	28	52
30	34	9·770693	17 49	10·229307	9·863517	17 75	10·136483	10·092825	17 26	9·907175	26	30
9	36	9·770779	18 52	10·229221	9·863650	18 80	10·136350	10·092871	18 28	9·907129	24	51
30	38	9·770866	19 55	10·229134	9·863783	19 84	10·136217	10·092917	19 29	9·907083	22	30
10	40	9·770952	20 58	10·229048	9·863915	20 88	10·136085	10·092963	20 31	9·907037	20	50
30	42	9·771039	21 60	10·228961	9·864048	21 93	10·135952	10·093009	21 32	9·906991	18	30
11	44	9·771125	22 63	10·228875	9·864180	22 97	10·135820	10·093055	22 34	9·906945	16	49
30	46	9·771211	23 66	10·228789	9·864313	23 102	10·135687	10·093102	23 35	9·906898	14	30
12	48	9·771298	24 69	10·228702	9·864445	24 106	10·135555	10·093148	24 37	9·906852	12	48
30	50	9·771384	25 72	10·228616	9·864578	25 110	10·135422	10·093194	25 38	9·906806	10	30
13	52	9·771470	26 75	10·228530	9·864710	26 115	10·135290	10·093240	26 40	9·906760	8	47
30	54	9·771556	27 78	10·228444	9·864843	27 119	10·135157	10·093287	27 41	9·906713	6	30
14	56	9·771643	28 81	10·228357	9·864975	28 124	10·135025	10·093333	28 43	9·906667	4	46
30	58	9·771729	29 84	10·228271	9·865108	29 128	10·134892	10·093379	29 45	9·906621	2	30
15	**25**	9·771815	30 86	10·228185	9·865240	30 133	10·134760	10·093425	30 46	9·906575	**35**	45
30	2	9·771901	1 3	10·228099	9·865373	1 4	10·134627	10·093472	1 2	9·906528	58	30
16	4	9·771987	2 6	10·228013	9·865505	2 9	10·134495	10·093518	2 3	9·906482	56	44
30	6	9·772073	3 9	10·227927	9·865638	3 13	10·134362	10·093564	3 5	9·906436	54	30
17	8	9·772159	4 11	10·227841	9·865770	4 18	10·134230	10·093611	4 6	9·906389	52	43
30	10	9·772245	5 14	10·227755	9·865903	5 22	10·134097	10·093657	5 8	9·906343	50	30
18	12	9·772331	6 17	10·227669	9·866035	6 26	10·133965	10·093704	6 9	9·906296	48	42
30	14	9·772417	7 20	10·227583	9·866167	7 31	10·133833	10·093750	7 11	9·906250	46	30
19	16	9·772503	8 23	10·227497	9·866300	8 35	10·133700	10·093796	8 12	9·906204	44	41
30	18	9·772589	9 26	10·227411	9·866432	9 40	10·133568	10·093843	9 14	9·906157	42	30
20	20	9·772675	10 29	10·227325	9·866564	10 44	10·133436	10·093889	10 15	9·906111	40	40
30	22	9·772761	11 32	10·227239	9·866697	11 49	10·133303	10·093936	11 17	9·906064	38	30
21	24	9·772847	12 34	10·227153	9·866829	12 53	10·133171	10·093982	12 19	9·906018	36	39
30	26	9·772933	13 37	10·227067	9·866961	13 57	10·133039	10·094029	13 20	9·905971	34	30
22	28	9·773018	14 40	10·226982	9·867094	14 62	10·132906	10·094075	14 22	9·905925	32	38
30	30	9·773104	15 43	10·226896	9·867226	15 66	10·132774	10·094122	15 23	9·905878	30	30
23	32	9·773190	16 46	10·226810	9·867358	16 71	10·132642	10·094168	16 25	9·905832	28	37
30	34	9·773276	17 49	10·226724	9·867491	17 75	10·132509	10·094215	17 26	9·905785	26	30
24	36	9·773361	18 51	10·226639	9·867623	18 79	10·132377	10·094261	18 28	9·905739	24	36
30	38	9·773447	19 54	10·226553	9·867755	19 84	10·132245	10·094308	19 29	9·905692	22	30
25	40	9·773533	20 57	10·226467	9·867887	20 88	10·132113	10·094355	20 31	9·905645	20	35
30	42	9·773618	21 60	10·226382	9·868019	21 93	10·131981	10·094401	21 33	9·905599	18	30
26	44	9·773704	22 63	10·226296	9·868152	22 97	10·131848	10·094448	22 34	9·905552	16	34
30	46	9·773789	23 66	10·226211	9·868284	23 101	10·131716	10·094494	23 36	9·905506	14	30
27	48	9·773875	24 69	10·226125	9·868416	24 106	10·131584	10·094541	24 37	9·905459	12	33
30	50	9·773960	25 72	10·226040	9·868548	25 110	10·131452	10·094588	25 39	9·905412	10	30
28	52	9·774046	26 74	10·225954	9·868680	26 115	10·131320	10·094634	26 40	9·905366	8	32
30	54	9·774131	27 77	10·225869	9·868813	27 119	10·131187	10·094681	27 42	9·905319	6	30
29	56	9·774217	28 80	10·225783	9·868945	28 123	10·131055	10·094728	28 43	9·905272	4	31
30	58	9·774302	29 83	10·225698	9·869077	29 128	10·130923	10·094775	29 45	9·905225	2	30
30	**26**	9·774388	30 86	10·225612	9·869209	30 132	10·130791	10·094821	30 46	9·905179	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

53° — $3^h\ 34^m$

LOG. SINES, COSINES, &c.

2h 26m — 36°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
30	0	9·774388		10·225612	9·869209		10·130791	10·094821		9·905179	34	30
30	2	9·774473	1″ 3	10·225527	9·869341	1″ 4	10·130659	10·094868	1″ 2	9·905132	58	30
31	4	9·774558	2 6	10·225442	9·869473	2 9	10·130527	10·094915	2 3	9·905085	56	29
30	6	9·774644	3 8	10·225356	9·869605	3 13	10·130395	10·094962	3 5	9·905038	54	30
32	8	9·774729	4 11	10·225271	9·869737	4 18	10·130263	10·095008	4 6	9·904992	52	28
30	10	9·774814	5 14	10·225186	9·869869	5 22	10·130131	10·095055	5 8	9·904945	50	30
33	12	9·774899	6 17	10·225101	9·870001	6 26	10·129999	10·095102	6 9	9·904898	48	27
30	14	9·774985	7 20	10·225015	9·870133	7 31	10·129867	10·095149	7 11	9·904851	46	30
34	16	9·775070	8 23	10·224930	9·870265	8 35	10·129735	10·095196	8 13	9·904804	44	26
30	18	9·775155	9 25	10·224845	9·870397	9 40	10·129603	10·095243	9 14	9·904757	42	30
35	20	9·775240	10 28	10·224760	9·870529	10 44	10·129471	10·095289	10 16	9·904711	40	25
30	22	9·775325	11 31	10·224675	9·870661	11 48	10·129339	10·095336	11 17	9·904664	38	30
36	24	9·775410	12 34	10·224590	9·870793	12 53	10·129207	10·095383	12 19	9·904617	36	24
30	26	9·775495	13 37	10·224505	9·870925	13 57	10·129075	10·095430	13 20	9·904570	34	30
37	28	9·775580	14 40	10·224420	9·871057	14 62	10·128943	10·095477	14 22	9·904523	32	23
30	30	9·775665	15 42	10·224335	9·871189	15 66	10·128811	10·095524	15 24	9·904476	30	30
38	32	9·775750	16 45	10·224250	9·871321	16 70	10·128679	10·095571	16 25	9·904429	28	22
30	34	9·775835	17 48	10·224165	9·871453	17 75	10·128547	10·095618	17 27	9·904382	26	30
39	36	9·775920	18 51	10·224080	9·871585	18 79	10·128415	10·095665	18 28	9·904335	24	21
30	38	9·776005	19 54	10·223995	9·871717	19 84	10·128283	10·095712	19 30	9·904288	22	30
40	40	9·776090	20 57	10·223910	9·871849	20 88	10·128151	10·095759	20 31	9·904241	20	20
30	42	9·776175	21 59	10·223825	9·871980	21 92	10·128020	10·095806	21 33	9·904194	18	30
41	44	9·776259	22 62	10·223741	9·872112	22 97	10·127888	10·095853	22 34	9·904147	16	19
30	46	9·776344	23 65	10·223656	9·872244	23 101	10·127756	10·095900	23 36	9·904100	14	30
42	48	9·776429	24 68	10·223571	9·872376	24 106	10·127624	10·095947	24 38	9·904053	12	18
30	50	9·776514	25 71	10·223486	9·872508	25 110	10·127492	10·095994	25 39	9·904006	10	30
43	52	9·776598	26 74	10·223402	9·872640	26 114	10·127360	10·096041	26 41	9·903959	8	17
30	54	9·776683	27 76	10·223317	9·872771	27 119	10·127229	10·096088	27 42	9·903912	6	30
44	56	9·776768	28 79	10·223232	9·872903	28 123	10·127097	10·096136	28 44	9·903864	4	16
30	58	9·776852	29 82	10·223148	9·873035	29 128	10·126965	10·096183	29 46	9·903817	2	30
45	**27**	9·776937	30 85	10·223063	9·873167	30 132	10·126833	10·096230	30 47	9·903770	**33**	15
30	2	9·777021	1 3	10·222979	9·873299	1 4	10·126701	10·096277	1 2	9·903723	58	30
46	4	9·777106	2 6	10·222894	9·873430	2 9	10·126570	10·096324	2 3	9·903676	56	14
30	6	9·777191	3 8	10·222809	9·873562	3 13	10·126438	10·096371	3 5	9·903629	54	30
47	8	9·777275	4 11	10·222725	9·873694	4 18	10·126306	10·096419	4 6	9·903581	52	13
30	10	9·777359	5 14	10·222641	9·873825	5 22	10·126175	10·096466	5 8	9·903534	50	30
48	12	9·777444	6 17	10·222556	9·873957	6 26	10·126043	10·096513	6 9	9·903487	48	12
30	14	9·777528	7 20	10·222472	9·874089	7 31	10·125911	10·096560	7 11	9·903440	46	30
49	16	9·777613	8 22	10·222387	9·874220	8 35	10·125780	10·096608	8 13	9·903392	44	11
30	18	9·777697	9 25	10·222303	9·874352	9 40	10·125648	10·096655	9 14	9·903345	42	30
50	20	9·777781	10 28	10·222219	9·874484	10 44	10·125516	10·096702	10 16	9·903298	40	10
30	22	9·777866	11 31	10·222134	9·874615	11 48	10·125385	10·096750	11 17	9·903250	38	30
51	24	9·777950	12 34	10·222050	9·874747	12 53	10·125253	10·096797	12 19	9·903203	36	9
30	26	9·778034	13 37	10·221966	9·874879	13 57	10·125121	10·096844	13 21	9·903156	34	30
52	28	9·778119	14 40	10·221881	9·875010	14 61	10·124990	10·096892	14 22	9·903108	32	8
30	30	9·778203	15 42	10·221797	9·875142	15 66	10·124858	10·096939	15 24	9·903061	30	30
53	32	9·778287	16 45	10·221713	9·875273	16 70	10·124727	10·096986	16 25	9·903014	28	7
30	34	9·778371	17 48	10·221629	9·875405	17 75	10·124595	10·097034	17 27	9·902966	26	30
54	36	9·778455	18 51	10·221545	9·875537	18 79	10·124463	10·097081	18 28	9·902919	24	6
30	38	9·778539	19 53	10·221461	9·875668	19 83	10·124332	10·097129	19 30	9·902871	22	30
55	40	9·778624	20 56	10·221376	9·875800	20 88	10·124200	10·097176	20 32	9·902824	20	5
30	42	9·778708	21 59	10·221292	9·875931	21 92	10·124069	10·097224	21 33	9·902776	18	30
56	44	9·778792	22 62	10·221208	9·876063	22 97	10·123937	10·097271	22 35	9·902729	16	4
30	46	9·778876	23 65	10·221124	9·876194	23 101	10·123806	10·097319	23 36	9·902681	14	30
57	48	9·778960	24 67	10·221040	9·876326	24 105	10·123674	10·097366	24 38	9·902634	12	3
30	50	9·779044	25 70	10·220956	9·876457	25 110	10·123543	10·097414	25 39	9·902586	10	30
58	52	9·779128	26 73	10·220872	9·876589	26 114	10·123411	10·097461	26 41	9·902539	8	2
30	54	9·779211	27 76	10·220789	9·876720	27 119	10·123280	10·097509	27 43	9·902491	6	30
59	56	9·779295	28 79	10·220705	9·876852	28 123	10·123148	10·097556	28 44	9·902444	4	1
30	58	9·779379	29 81	10·220621	9·876983	29 127	10·123017	10·097604	29 46	9·902396	2	30
60	**28**	9·779463	30 84	10·220537	9·877114	30 132	10·122886	10·097651	30 47	9·902349	0	0
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

53° — 3h 32m

LOG. SINES, COSINES, &c.

2h 28m — 37°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
0	0	9·779463		10·220537	9·877114		10·122886	10·097651		9·902349	**32**	60
30	2	9·779547	1″ 3	10·220453	9·877246	1 4	10·122754	10·097699	1″ 2	9·902301	58	30
1	4	9·779631	2 6	10·220369	9·877377	2 9	10·122623	10·097747	2 3	9·902253	56	59
30	6	9·779714	3 8	10·220286	9·877509	3 13	10·122491	10·097794	3 5	9·902206	54	30
2	8	9·779798	4 11	10·220202	9·877640	4 17	10·122360	10·097842	4 6	9·902158	52	58
30	10	9·779882	5 14	10·220118	9·877771	5 22	10·122229	10·097890	5 8	9·902110	50	30
3	12	9·779966	6 17	10·220034	9·877903	6 26	10·122097	10·097937	6 10	9·902063	48	57
30	14	9·780049	7 19	10·219951	9·878034	7 31	10·121966	10·097985	7 11	9·902015	46	30
4	16	9·780133	8 22	10·219867	9·878165	8 35	10·121835	10·098033	8 13	9·901967	44	56
30	18	9·780216	9 25	10·219784	9·878297	9 39	10·121703	10·098080	9 14	9·901920	42	30
5	20	9·780300	10 28	10·219700	9·878428	10 44	10·121572	10·098128	10 16	9·901872	40	55
30	22	9·780384	11 31	10·219616	9·878559	11 48	10·121441	10·098176	11 18	9·901824	38	30
6	24	9·780467	12 34	10·219533	9·878691	12 52	10·121309	10·098224	12 19	9·901776	36	54
30	26	9·780551	13 36	10·219449	9·878822	13 57	10·121178	10·098271	13 21	9·901729	34	30
7	28	9·780634	14 39	10·219366	9·878953	14 61	10·121047	10·098319	14 22	9·901681	32	53
30	30	9·780718	15 42	10·219282	9·879085	15 66	10·120915	10·098367	15 24	9·901633	30	30
8	32	9·780801	16 45	10·219199	9·879216	16 70	10·120784	10·098415	16 25	9·901585	28	52
30	34	9·780884	17 47	10·219116	9·879347	17 74	10·120653	10·098463	17 27	9·901537	26	30
9	36	9·780968	18 50	10·219032	9·879478	18 79	10·120522	10·098510	18 29	9·901490	24	51
30	38	9·781051	19 53	10·218949	9·879609	19 83	10·120391	10·098558	19 30	9·901442	22	30
10	40	9·781134	20 56	10·218866	9·879741	20 87	10·120259	10·098606	20 32	9·901394	20	50
30	42	9·781218	21 58	10·218782	9·879872	21 92	10·120128	10·098654	21 33	9·901346	18	30
11	44	9·781301	22 61	10·218699	9·880003	22 96	10·119997	10·098702	22 35	9·901298	16	49
30	46	9·781384	23 64	10·218616	9·880134	23 101	10·119866	10·098750	23 37	9·901250	14	30
12	48	9·781468	24 67	10·218532	9·880265	24 105	10·119735	10·098798	24 38	9·901202	12	48
30	50	9·781551	25 70	10·218449	9·880397	25 109	10·119603	10·098846	25 40	9·901154	10	30
13	52	9·781634	26 73	10·218366	9·880528	26 114	10·119472	10·098894	26 41	9·901106	8	47
30	54	9·781717	27 75	10·218283	9·880659	27 118	10·119341	10·098942	27 43	9·901058	6	30
14	56	9·781800	28 78	10·218200	9·880790	28 122	10·119210	10·098990	28 45	9·901010	4	46
30	58	9·781883	29 81	10·218117	9·880921	29 127	10·119079	10·099038	29 46	9·900962	2	30
15	**29**	9·781966	30 83	10·218034	9·881052	30 131	10·118948	10·099086	30 48	9·900914	**31**	45
30	2	9·782049	1 3	10·217951	9·881183	1 4	10·118817	10·099134	1 2	9·900866	58	30
16	4	9·782132	2 6	10·217868	9·881314	2 9	10·118686	10·099182	2 3	9·900818	56	44
30	6	9·782215	3 8	10·217785	9·881445	3 13	10·118555	10·099230	3 5	9·900770	54	30
17	8	9·782298	4 11	10·217702	9·881577	4 17	10·118423	10·099278	4 6	9·900722	52	43
30	10	9·782381	5 14	10·217619	9·881708	5 22	10·118292	10·099326	5 8	9·900674	50	30
18	12	9·782464	6 17	10·217536	9·881839	6 26	10·118161	10·099374	6 10	9·900626	48	42
30	14	9·782547	7 19	10·217453	9·881970	7 31	10·118030	10·099422	7 11	9·900578	46	30
19	16	9·782630	8 22	10·217370	9·882101	8 35	10·117899	10·099471	8 13	9·900529	44	41
30	18	9·782713	9 25	10·217287	9·882232	9 39	10·117768	10·099519	9 14	9·900481	42	30
20	20	9·782796	10 28	10·217204	9·882363	10 44	10·117637	10·099567	10 16	9·900433	40	40
30	22	9·782879	11 30	10·217121	9·882494	11 48	10·117506	10·099615	11 18	9·900385	38	30
21	24	9·782961	12 33	10·217039	9·882625	12 52	10·117375	10·099663	12 19	9·900337	36	39
30	26	9·783044	13 36	10·216956	9·882756	13 57	10·117244	10·099711	13 21	9·900289	34	30
22	28	9·783127	14 39	10·216873	9·882887	14 61	10·117113	10·099760	14 23	9·900240	32	38
30	30	9·783210	15 41	10·216790	9·883018	15 65	10·116982	10·099808	15 24	9·900192	30	30
23	32	9·783292	16 44	10·216708	9·883148	16 70	10·116852	10·099856	16 26	9·900144	28	37
30	34	9·783375	17 47	10·216625	9·883279	17 74	10·116721	10·099904	17 27	9·900096	26	30
24	36	9·783458	18 50	10·216542	9·883410	18 78	10·116590	10·099953	18 29	9·900047	24	36
30	38	9·783540	19 52	10·216460	9·883541	19 83	10·116459	10·100001	19 31	9·899999	22	30
25	40	9·783623	20 55	10·216377	9·883672	20 87	10·116328	10·100049	20 32	9·899951	20	35
30	42	9·783705	21 58	10·216295	9·883803	21 92	10·116197	10·100098	21 34	9·899902	18	30
26	44	9·783788	22 61	10·216212	9·883934	22 96	10·116066	10·100146	22 35	9·899854	16	34
30	46	9·783870	23 63	10·216130	9·884065	23 100	10·115935	10·100194	23 37	9·899806	14	30
27	48	9·783953	24 66	10·216047	9·884196	24 105	10·115804	10·100243	24 39	9·899757	12	33
30	50	9·784035	25 69	10·215965	9·884326	25 109	10·115674	10·100291	25 40	9·899709	10	30
28	52	9·784118	26 72	10·215882	9·884457	26 113	10·115543	10·100340	26 42	9·899660	8	32
30	54	9·784200	27 74	10·215800	9·884588	27 118	10·115412	10·100388	27 43	9·899612	6	30
29	56	9·784282	28 77	10·215718	9·884719	28 122	10·115281	10·100436	28 45	9·899564	4	31
30	58	9·784365	29 80	10·215635	9·884850	29 126	10·115150	10·100485	29 47	9·899515	2	30
30	**30**	9·784447	30 83	10·215553	9·884980	30 131	10·115020	10·100533	30 48	9·899467	0	30
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

52° — 3h 30m

LOG. SINES, COSINES, &c.

2h 30m 37°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
30	0	9·784447		10·215553	9·884980		10·115020	10·100533		9·899467	30	30
30	2	9·784529	1″ 3	10·215471	9·885111	1″ 4	10·114889	10·100582	1″ 2	9·899418	58	30
31	4	9·784612	2 5	10·215388	9·885242	2 9	10·114758	10·100630	2 3	9·899370	56	29
30	6	9·784694	3 8	10·215306	9·885373	3 13	10·114627	10·100679	3 5	9·899321	54	30
32	8	9·784776	4 11	10·215224	9·885504	4 17	10·114496	10·100727	4 6	9·899273	52	28
30	10	9·784858	5 14	10·215142	9·885634	5 22	10·114366	10·100776	5 8	9·899224	50	30
33	12	9·784941	6 16	10·215059	9·885765	6 26	10·114235	10·100824	6 10	9·899176	48	27
30	14	9·785023	7 19	10·214977	9·885896	7 30	10·114104	10·100873	7 11	9·899127	46	30
34	16	9·785105	8 22	10·214895	9·886026	8 35	10·113974	10·100922	8 13	9·899078	44	26
30	18	9·785187	9 25	10·214813	9·886157	9 39	10·113843	10·100970	9 15	9·899030	42	30
35	20	9·785269	10 27	10·214731	9·886288	10 43	10·113712	10·101019	10 16	9·898981	40	25
30	22	9·785351	11 30	10·214649	9·886419	11 48	10·113581	10·101067	11 18	9·898933	38	30
36	24	9·785433	12 33	10·214567	9·886549	12 52	10·113451	10·101116	12 19	9·898884	36	24
30	26	9·785515	13 36	10·214485	9·886680	13 57	10·113320	10·101165	13 21	9·898835	34	30
37	28	9·785597	14 39	10·214403	9·886811	14 61	10·113189	10·101213	14 23	9·898787	32	23
30	30	9·785679	15 41	10·214321	9·886941	15 65	10·113059	10·101262	15 24	9·898738	30	30
38	32	9·785761	16 44	10·214239	9·887072	16 70	10·112928	10·101311	16 26	9·898689	28	22
30	34	9·785843	17 47	10·214157	9·887202	17 74	10·112798	10·101359	17 28	9·898641	26	30
39	36	9·785925	18 49	10·214075	9·887333	18 78	10·112667	10·101408	18 29	9·898592	24	21
30	38	9·786007	19 52	10·213993	9·887464	19 83	10·112536	10·101457	19 31	9·898543	22	30
40	40	9·786089	20 55	10·213911	9·887594	20 87	10·112406	10·101506	20 32	9·898494	20	20
30	42	9·786170	21 57	10·213830	9·887725	21 91	10·112275	10·101554	21 34	9·898446	18	30
41	44	9·786252	22 60	10·213748	9·887855	22 96	10·112145	10·101603	22 36	9·898397	16	19
30	46	9·786334	23 63	10·213666	9·887986	23 100	10·112014	10·101652	23 37	9·898348	14	30
42	48	9·786416	24 66	10·213584	9·888116	24 104	10·111884	10·101701	24 39	9·898299	12	18
30	50	9·786497	25 68	10·213503	9·888247	25 109	10·111753	10·101750	25 41	9·898250	10	30
43	52	9·786579	26 71	10·213421	9·888378	26 113	10·111622	10·101798	26 42	9·898202	8	17
30	54	9·786661	27 74	10·213339	9·888508	27 117	10·111492	10·101847	27 44	9·898153	6	30
44	56	9·786742	28 77	10·213258	9·888639	28 122	10·111361	10·101896	28 46	9·898104	4	16
30	58	9·786824	29 80	10·213176	9·888769	29 126	10·111231	10·101945	29 47	9·898055	2	30
45	**31**	9·786906	30 82	10·213094	9·888900	30 130	10·111100	10·101994	30 48	9·898006	**29**	15
30	2	9·786987	1 3	10·213013	9·889030	1 4	10·110970	10·102043	1 2	9·897957	58	30
46	4	9·787069	2 5	10·212931	9·889161	2 9	10·110839	10·102092	2 3	9·897908	56	14
30	6	9·787150	3 8	10·212850	9·889291	3 13	10·110709	10·102141	3 5	9·897859	54	30
47	8	9·787232	4 11	10·212768	9·889421	4 17	10·110579	10·102190	4 7	9·897810	52	13
30	10	9·787313	5 14	10·212687	9·889552	5 22	10·110448	10·102239	5 8	9·897761	50	30
48	12	9·787395	6 16	10·212605	9·889682	6 26	10·110318	10·102288	6 10	9·897712	48	12
30	14	9·787476	7 19	10·212524	9·889813	7 30	10·110187	10·102337	7 11	9·897663	46	30
49	16	9·787557	8 22	10·212443	9·889943	8 35	10·110057	10·102386	8 13	9·897614	44	11
30	18	9·787639	9 24	10·212361	9·890074	9 39	10·109926	10·102435	9 15	9·897565	42	30
50	20	9·787720	10 27	10·212280	9·890204	10 43	10·109796	10·102484	10 16	9·897516	40	10
30	22	9·787801	11 30	10·212199	9·890334	11 48	10·109666	10·102533	11 18	9·897467	38	30
51	24	9·787883	12 33	10·212117	9·890465	12 52	10·109535	10·102582	12 20	9·897418	36	9
30	26	9·787964	13 35	10·212036	9·890595	13 56	10·109405	10·102631	13 21	9·897369	34	30
52	28	9·788045	14 38	10·211955	9·890725	14 61	10·109275	10·102680	14 23	9·897320	32	8
30	30	9·788127	15 41	10·211873	9·890856	15 65	10·109144	10·102729	15 25	9·897271	30	30
53	32	9·788208	16 43	10·211792	9·890986	16 69	10·109014	10·102778	16 26	9·897222	28	7
30	34	9·788289	17 46	10·211711	9·891116	17 74	10·108884	10·102828	17 28	9·897172	26	30
54	36	9·788370	18 49	10·211630	9·891247	18 78	10·108753	10·102877	18 29	9·897123	24	6
30	38	9·788451	19 51	10·211549	9·891377	19 82	10·108623	10·102926	19 31	9·897074	22	30
55	40	9·788532	20 54	10·211468	9·891507	20 87	10·108493	10·102975	20 33	9·897025	20	5
30	42	9·788613	21 57	10·211387	9·891638	21 91	10·108362	10·103024	21 34	9·896976	18	30
56	44	9·788694	22 60	10·211306	9·891768	22 95	10·108232	10·103074	22 36	9·896926	16	4
30	46	9·788775	23 62	10·211225	9·891898	23 100	10·108102	10·103123	23 38	9·896877	14	30
57	48	9·788856	24 65	10·211144	9·892028	24 104	10·107972	10·103172	24 39	9·896828	12	3
30	50	9·788937	25 68	10·211063	9·892159	25 108	10·107841	10·103221	25 41	9·896779	10	30
58	52	9·789018	26 71	10·210982	9·892289	26 113	10·107711	10·103271	26 42	9·896729	8	2
30	54	9·789099	27 73	10·210901	9·892419	27 117	10·107581	10·103320	27 44	9·896680	6	30
59	56	9·789180	28 76	10·210820	9·892549	28 122	10·107451	10·103369	28 46	9·896631	4	1
30	58	9·789261	29 79	10·210739	9·892680	29 126	10·107320	10·103419	29 48	9·896581	2	30
60	**32**	9·789342	30 81	10·210658	9·892810	30 130	10·107190	10·103468	30 49	9·896532	0	0
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

52° 3h 28m

LOG. SINES, COSINES, &c.

2ʰ 32ᵐ — 38°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·789342		10·210658	9·892810		10·107190	10·103468		9·896532	28	60
30	2	9·789423	1″ 3	10·210577	9·892940	1″ 4	10·107060	10·103517	1″ 2	9·896483	58	30
1	4	9·789504	2 5	10·210496	9·893070	2 9	10·106930	10·103567	2 3	9·896433	56	59
30	6	9·789584	3 8	10·210416	9·893200	3 13	10·106800	10·103616	3 5	9·896384	54	30
2	8	9·789665	4 11	10·210335	9·893331	4 17	10·106669	10·103665	4 7	9·896335	52	58
30	10	9·789746	5 13	10·210254	9·893461	5 22	10·106539	10·103715	5 8	9·896285	50	30
3	12	9·789827	6 16	10·210173	9·893591	6 26	10·106409	10·103764	6 10	9·896236	48	57
30	14	9·789907	7 19	10·210093	9·893721	7 30	10·106279	10·103814	7 12	9·896186	46	30
4	16	9·789988	8 21	10·210012	9·893851	8 35	10·106149	10·103863	8 13	9·896137	44	56
30	18	9·790069	9 24	10·209931	9·893981	9 39	10·106019	10·103913	9 15	9·896087	42	30
5	20	9·790149	10 27	10·209851	9·894111	10 43	10·105889	10·103962	10 16	9·896038	40	55
30	22	9·790230	11 29	10·209770	9·894241	11 48	10·105759	10·104012	11 18	9·895988	38	30
6	24	9·790310	12 32	10·209690	9·894372	12 52	10·105628	10·104061	12 20	9·895939	36	54
30	26	9·790391	13 35	10·209609	9·894502	13 56	10·105498	10·104111	13 21	9·895889	34	30
7	28	9·790471	14 37	10·209529	9·894632	14 61	10·105368	10·104160	14 23	9·895840	32	53
30	30	9·790552	15 40	10·209448	9·894762	15 65	10·105238	10·104210	15 25	9·895790	30	30
8	32	9·790632	16 43	10·209368	9·894892	16 69	10·105108	10·104259	16 26	9·895741	28	52
30	34	9·790713	17 46	10·209287	9·895022	17 74	10·104978	10·104309	17 28	9·895691	26	30
9	36	9·790793	18 48	10·209207	9·895152	18 78	10·104848	10·104359	18 30	9·895641	24	51
30	38	9·790874	19 51	10·209126	9·895282	19 82	10·104718	10·104408	19 31	9·895592	22	30
10	40	9·790954	20 54	10·209046	9·895412	20 87	10·104588	10·104458	20 33	9·895542	20	50
30	42	9·791034	21 56	10·208966	9·895542	21 91	10·104458	10·104507	21 35	9·895493	18	30
11	44	9·791115	22 59	10·208885	9·895672	22 95	10·104328	10·104557	22 36	9·895443	16	49
30	46	9·791195	23 62	10·208805	9·895802	23 100	10·104198	10·104607	23 38	9·895393	14	30
12	48	9·791275	24 65	10·208725	9·895932	24 104	10·104068	10·104657	24 40	9·895343	12	48
30	50	9·791356	25 67	10·208644	9·896062	25 108	10·103938	10·104706	25 41	9·895294	10	30
13	52	9·791436	26 70	10·208564	9·896192	26 113	10·103808	10·104756	26 43	9·895244	8	47
30	54	9·791516	27 72	10·208484	9·896322	27 117	10·103678	10·104806	27 45	9·895194	6	30
14	56	9·791596	28 75	10·208404	9·896452	28 121	10·103548	10·104855	28 46	9·895145	4	46
30	58	9·791676	29 78	10·208324	9·896582	29 126	10·103418	10·104905	29 48	9·895095	2	30
15	33	9·791757	30 80	10·208243	9·896712	30 130	10·103288	10·104955	30 50	9·895045	27	45
30	2	9·791837	1 3	10·208163	9·896842	1 4	10·103158	10·105005	1 2	9·894995	58	30
16	4	9·791917	2 5	10·208083	9·896971	2 9	10·103029	10·105055	2 3	9·894945	56	44
30	6	9·791997	3 8	10·208003	9·897101	3 13	10·102899	10·105104	3 5	9·894896	54	30
17	8	9·792077	4 11	10·207923	9·897231	4 17	10·102769	10·105154	4 7	9·894846	52	43
30	10	9·792157	5 13	10·207843	9·897361	5 22	10·102639	10·105204	5 8	9·894796	50	30
18	12	9·792237	6 16	10·207763	9·897491	6 26	10·102509	10·105254	6 10	9·894746	48	42
30	14	9·792317	7 19	10·207683	9·897621	7 30	10·102379	10·105304	7 12	9·894696	46	30
19	16	9·792397	8 21	10·207603	9·897751	8 35	10·102249	10·105354	8 13	9·894646	44	41
30	18	9·792477	9 24	10·207523	9·897881	9 39	10·102119	10·105404	9 15	9·894596	42	30
20	20	9·792557	10 27	10·207443	9·898010	10 43	10·101990	10·105454	10 17	9·894546	40	40
30	22	9·792636	11 30	10·207364	9·898140	11 48	10·101860	10·105504	11 18	9·894496	38	30
21	24	9·792716	12 32	10·207284	9·898270	12 52	10·101730	10·105554	12 20	9·894446	36	39
30	26	9·792796	13 35	10·207204	9·898400	13 56	10·101600	10·105604	13 22	9·894396	34	30
22	28	9·792876	14 37	10·207124	9·898530	14 61	10·101470	10·105654	14 23	9·894346	32	38
30	30	9·792956	15 40	10·207044	9·898659	15 65	10·101341	10·105704	15 25	9·894296	30	30
23	32	9·793035	16 43	10·206965	9·898789	16 69	10·101211	10·105754	16 27	9·894246	28	37
30	34	9·793115	17 45	10·206885	9·898919	17 74	10·101081	10·105804	17 28	9·894196	26	30
24	36	9·793195	18 48	10·206805	9·899049	18 78	10·100951	10·105854	18 30	9·894146	24	36
30	38	9·793275	19 51	10·206725	9·899178	19 82	10·100822	10·105904	19 32	9·894096	22	30
25	40	9·793354	20 53	10·206646	9·899308	20 86	10·100692	10·105954	20 33	9·894046	20	35
30	42	9·793434	21 56	10·206566	9·899438	21 91	10·100562	10·106004	21 35	9·893996	18	30
26	44	9·793514	22 59	10·206486	9·899568	22 95	10·100432	10·106054	22 37	9·893946	16	34
30	46	9·793593	23 61	10·206407	9·899697	23 99	10·100303	10·106104	23 38	9·893896	14	30
27	48	9·793673	24 64	10·206327	9·899827	24 104	10·100173	10·106154	24 40	9·893846	12	33
30	50	9·793752	25 67	10·206248	9·899957	25 108	10·100043	10·106205	25 42	9·893795	10	30
28	52	9·793832	26 69	10·206168	9·900087	26 112	10·099913	10·106255	26 43	9·893745	8	32
30	54	9·793911	27 72	10·206089	9·900216	27 117	10·099784	10·106305	27 45	9·893695	6	30
29	56	9·793991	28 74	10·206009	9·900346	28 121	10·099654	10·106355	28 47	9·893645	4	31
30	58	9·794070	29 77	10·205930	9·900475	29 125	10·099524	10·106405	29 48	9·893595	2	30
30	34	9·794150	30 80	10·205850	9·900605	30 130	10·099395	10·106456	30 50	9·893544	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

51° — 3ʰ 26ᵐ

LOG. SINES, COSINES, &c.

2ʰ 34ᵐ — 38°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
30	0	9·794150		10·205850	9·900605		10·099395	10·106456		9·893544	**26**	30
30	2	9·794229	1″ 3	10·205771	9·900735	1″ 4	10·099265	10·106506	1″ 2	9·893494	58	30
31	4	9·794308	2 5	10·205692	9·900864	2 9	10·099136	10·106556	2 3	9·893444	56	29
30	6	9·794388	3 8	10·205612	9·900994	3 13	10·099006	10·106606	3 5	9·893394	54	30
32	8	9·794467	4 11	10·205533	9·901124	4 17	10·098876	10·106657	4 7	9·893343	52	28
30	10	9·794546	5 13	10·205454	9·901253	5 22	10·098747	10·106707	5 8	9·893293	50	30
33	12	9·794626	6 16	10·205374	9·901383	6 26	10·098617	10·106757	6 10	9·893243	48	27
30	14	9·794705	7 19	10·205295	9·901513	7 30	10·098487	10·106808	7 12	9·893192	46	30
34	16	9·794784	8 21	10·205216	9·901642	8 35	10·098358	10·106858	8 13	9·893142	44	26
30	18	9·794863	9 24	10·205137	9·901772	9 39	10·098228	10·106908	9 15	9·893092	42	30
35	20	9·794942	10 26	10·205058	9·901901	10 43	10·098099	10·106959	10 17	9·893041	40	25
30	22	9·795022	11 29	10·204978	9·902031	11 48	10·097969	10·107009	11 18	9·892991	38	30
36	24	9·795101	12 32	10·204899	9·902160	12 52	10·097840	10·107060	12 20	9·892940	36	24
30	26	9·795180	13 34	10·204820	9·902290	13 56	10·097710	10·107110	13 22	9·892890	34	30
37	28	9·795259	14 37	10·204741	9·902420	14 60	10·097580	10·107161	14 24	9·892839	32	23
30	30	9·795338	15 39	10·204662	9·902549	15 65	10·097451	10·107211	15 25	9·892789	30	30
38	32	9·795417	16 42	10·204583	9·902679	16 69	10·097321	10·107261	16 27	9·892739	28	22
30	34	9·795496	17 45	10·204504	9·902808	17 73	10·097192	10·107312	17 29	9·892688	26	30
39	36	9·795575	18 47	10·204425	9·902938	18 78	10·097062	10·107362	18 30	9·892638	24	21
30	38	9·795654	19 50	10·204346	9·903067	19 82	10·096933	10·107413	19 32	9·892587	22	30
40	40	9·795733	20 53	10·204267	9·903197	20 86	10·096803	10·107464	20 34	9·892536	20	20
30	42	9·795812	21 55	10·204188	9·903326	21 91	10·096674	10·107514	21 35	9·892486	18	30
41	44	9·795891	22 58	10·204109	9·903456	22 95	10·096544	10·107565	22 37	9·892435	16	19
30	46	9·795970	23 60	10·204030	9·903585	23 99	10·096415	10·107615	23 39	9·892385	14	30
42	48	9·796049	24 63	10·203951	9·903714	24 104	10·096286	10·107666	24 40	9·892334	12	18
30	50	9·796127	25 66	10·203873	9·903844	25 108	10·096156	10·107716	25 42	9·892284	10	30
43	52	9·796206	26 68	10·203794	9·903973	26 112	10·096027	10·107767	26 44	9·892233	8	17
30	54	9·796285	27 71	10·203715	9·904103	27 117	10·095897	10·107818	27 45	9·892182	6	30
44	56	9·796364	28 74	10·203636	9·904232	28 121	10·095768	10·107868	28 47	9·892132	4	16
30	58	9·796443	29 76	10·203557	9·904362	29 125	10·095638	10·107919	29 49	9·892081	2	30
45	**35**	9·796521	30 79	10·203479	9·904491	30 130	10·095509	10·107970	30 50	9·892030	**25**	15
30	2	9·796600	1 3	10·203400	9·904620	1 4	10·095380	10·108020	1 2	9·891980	58	30
46	4	9·796679	2 5	10·203321	9·904750	2 9	10·095250	10·108071	2 3	9·891929	56	14
30	6	9·796757	3 8	10·203243	9·904879	3 13	10·095121	10·108122	3 5	9·891878	54	30
47	8	9·796836	4 10	10·203164	9·905008	4 17	10·094992	10·108173	4 7	9·891827	52	13
30	10	9·796914	5 13	10·203086	9·905138	5 22	10·094862	10·108223	5 8	9·891777	50	30
48	12	9·796993	6 16	10·203007	9·905267	6 26	10·094733	10·108274	6 10	9·891726	48	12
30	14	9·797072	7 18	10·202928	9·905397	7 30	10·094603	10·108325	7 12	9·891675	46	30
49	16	9·797150	8 21	10·202850	9·905526	8 34	10·094474	10·108376	8 14	9·891624	44	11
30	18	9·797229	9 23	10·202771	9·905655	9 39	10·094345	10·108427	9 15	9·891573	42	30
50	20	9·797307	10 26	10·202693	9·905785	10 43	10·094215	10·108477	10 17	9·891523	40	10
30	22	9·797386	11 29	10·202614	9·905914	11 47	10·094086	10·108528	11 19	9·891472	38	30
51	24	9·797464	12 31	10·202536	9·906043	12 52	10·093957	10·108579	12 20	9·891421	36	9
30	26	9·797542	13 34	10·202458	9·906172	13 56	10·093828	10·108630	13 22	9·891370	34	30
52	28	9·797621	14 37	10·202379	9·906302	14 60	10·093698	10·108681	14 24	9·891319	32	8
30	30	9·797699	15 39	10·202301	9·906431	15 65	10·093569	10·108732	15 25	9·891268	30	30
53	32	9·797777	16 42	10·202223	9·906560	16 69	10·093440	10·108783	16 27	9·891217	28	7
30	34	9·797856	17 45	10·202144	9·906690	17 73	10·093310	10·108834	17 29	9·891166	26	30
54	36	9·797934	18 47	10·202066	9·906819	18 78	10·093181	10·108885	18 31	9·891115	24	6
30	38	9·798012	19 50	10·201988	9·906948	19 82	10·093052	10·108936	19 32	9·891064	22	30
55	40	9·798091	20 52	10·201909	9·907077	20 86	10·092923	10·108987	20 34	9·891013	20	5
30	42	9·798169	21 55	10·201831	9·907207	21 91	10·092793	10·109038	21 36	9·890962	18	30
56	44	9·798247	22 58	10·201753	9·907336	22 95	10·092664	10·109089	22 37	9·890911	16	4
30	46	9·798325	23 60	10·201675	9·907465	23 99	10·092535	10·109140	23 39	9·890860	14	30
57	48	9·798403	24 63	10·201597	9·907594	24 103	10·092406	10·109191	24 41	9·890809	12	3
30	50	9·798482	25 65	10·201518	9·907723	25 108	10·092277	10·109242	25 42	9·890758	10	30
58	52	9·798560	26 68	10·201440	9·907853	26 112	10·092147	10·109293	26 44	9·890707	8	2
30	54	9·798638	27 70	10·201362	9·907982	27 116	10·092018	10·109344	27 46	9·890656	6	30
59	56	9·798716	28 73	10·201284	9·908111	28 121	10·091889	10·109395	28 48	9·890605	4	1
30	58	9·798794	29 76	10·201206	9·908240	29 125	10·091760	10·109446	29 49	9·890554	2	30
60	**36**	9·798872	30 78	10·201128	9·908369	30 129	10·091631	10·109497	30 51	9·890503	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

51° — 3ʰ 24ᵐ

LOG. SINES, COSINES, &c.

2ʰ 36ᵐ — 39°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·798872		10·201128	9·908369		10·091631	10·109497		9·890503	24	60
30	2	9·798950	1″ 3	10·201050	9·908498	1″ 4	10·091502	10·109549	1″ 2	9·890451	58	30
1	4	9·799028	2 5	10·200972	9·908628	2 9	10·091372	10·109600	2 3	9·890400	56	59
30	6	9·799106	3 8	10·200894	9·908757	3 13	10·091243	10·109651	3 5	9·890349	54	30
2	8	9·799184	4 10	10·200816	9·908886	4 17	10·091114	10·109702	4 7	9·890298	52	58
30	10	9·799262	5 13	10·200738	9·909015	5 21	10·090985	10·109753	5 9	9·890247	50	30
3	12	9·799339	6 16	10·200661	9·909144	6 26	10·090856	10·109805	6 10	9·890195	48	57
30	14	9·799417	7 18	10·200583	9·909273	7 30	10·090727	10·109856	7 12	9·890144	46	30
4	16	9·799495	8 21	10·200505	9·909402	8 34	10·090598	10·109907	8 14	9·890093	44	56
30	18	9·799573	9 23	10·200427	9·909531	9 38	10·090469	10·109958	9 15	9·890042	42	30
5	20	9·799651	10 26	10·200349	9·909660	10 43	10·090340	10·110010	10 17	9·889990	40	55
30	22	9·799728	11 28	10·200272	9·909789	11 47	10·090211	10·110061	11 19	9·889939	38	30
6	24	9·799806	12 31	10·200194	9·909918	12 52	10·090082	10·110112	12 21	9·889888	36	54
30	26	9·799884	13 33	10·200116	9·910048	13 56	10·089952	10·110164	13 22	9·889836	34	30
7	28	9·799962	14 36	10·200038	9·910177	14 60	10·089823	10·110215	14 24	9·889785	32	53
30	30	9·800039	15 38	10·199961	9·910306	15 64	10·089694	10·110266	15 26	9·889734	30	30
8	32	9·800117	16 41	10·199883	9·910435	16 69	10·089565	10·110318	16 27	9·889682	28	52
30	34	9·800195	17 44	10·199805	9·910564	17 73	10·089436	10·110369	17 29	9·889631	26	30
9	36	9·800272	18 47	10·199728	9·910693	18 77	10·089307	10·110421	18 31	9·889579	24	51
30	38	9·800350	19 50	10·199650	9·910822	19 82	10·089178	10·110472	19 32	9·889528	22	30
10	40	9·800427	20 52	10·199573	9·910951	20 86	10·089049	10·110523	20 34	9·889477	20	50
30	42	9·800505	21 55	10·199495	9·911080	21 90	10·088920	10·110575	21 36	9·889425	18	30
11	44	9·800582	22 57	10·199418	9·911209	22 95	10·088791	10·110626	22 38	9·889374	16	49
30	46	9·800660	23 60	10·199340	9·911338	23 99	10·088662	10·110678	23 39	9·889322	14	30
12	48	9·800737	24 62	10·199263	9·911467	24 103	10·088533	10·110729	24 41	9·889271	12	48
30	50	9·800815	25 65	10·199185	9·911596	25 107	10·088404	10·110781	25 43	9·889219	10	30
13	52	9·800892	26 67	10·199108	9·911725	26 112	10·088275	10·110832	26 44	9·889168	8	47
30	54	9·800969	27 70	10·199031	9·911853	27 116	10·088147	10·110884	27 46	9·889116	6	30
14	56	9·801047	28 73	10·198953	9·911982	28 120	10·088018	10·110936	28 48	9·889064	4	46
30	58	9·801124	29 75	10·198876	9·912111	29 125	10·087889	10·110987	29 50	9·889013	2	30
15	**37**	9·801201	30 78	10·198799	9·912240	30 129	10·087760	10·111039	30 51	9·888961	**23**	45
30	2	9·801279	1 3	10·198721	9·912369	1 4	10·087631	10·111090	1 2	9·888910	58	30
16	4	9·801356	2 5	10·198644	9·912498	2 9	10·087502	10·111142	2 3	9·888858	56	44
30	6	9·801433	3 8	10·198567	9·912627	3 13	10·087373	10·111194	3 5	9·888806	54	30
17	8	9·801511	4 10	10·198489	9·912756	4 17	10·087244	10·111245	4 7	9·888755	52	43
30	10	9·801588	5 13	10·198412	9·912885	5 21	10·087115	10·111297	5 9	9·888703	50	30
18	12	9·801665	6 15	10·198335	9·913014	6 26	10·086986	10·111349	6 10	9·888651	48	42
30	14	9·801742	7 18	10·198258	9·913143	7 30	10·086857	10·111400	7 12	9·888600	46	30
19	16	9·801819	8 21	10·198181	9·913271	8 34	10·086729	10·111452	8 14	9·888548	44	41
30	18	9·801896	9 23	10·198104	9·913400	9 39	10·086600	10·111504	9 16	9·888496	42	30
20	20	9·801973	10 26	10·198027	9·913529	10 43	10·086471	10·111556	10 17	9·888444	40	40
30	22	9·802051	11 28	10·197949	9·913658	11 47	10·086342	10·111607	11 19	9·888393	38	30
21	24	9·802128	12 31	10·197872	9·913787	12 51	10·086213	10·111659	12 21	9·888341	36	39
30	26	9·802205	13 33	10·197795	9·913916	13 56	10·086084	10·111711	13 22	9·888289	34	30
22	28	9·802282	14 36	10·197718	9·914044	14 60	10·085956	10·111763	14 24	9·888237	32	38
30	30	9·802359	15 38	10·197641	9·914173	15 64	10·085827	10·111815	15 26	9·888185	30	30
23	32	9·802436	16 41	10·197564	9·914302	16 69	10·085698	10·111866	16 28	9·888134	28	37
30	34	9·802512	17 43	10·197488	9·914431	17 73	10·085569	10·111918	17 29	9·888082	26	30
24	36	9·802589	18 46	10·197411	9·914560	18 77	10·085440	10·111970	18 31	9·888030	24	36
30	38	9·802666	19 48	10·197334	9·914688	19 82	10·085312	10·112022	19 33	9·887978	22	30
25	40	9·802743	20 51	10·197257	9·914817	20 86	10·085183	10·112074	20 35	9·887926	20	35
30	42	9·802820	21 54	10·197180	9·914946	21 90	10·085054	10·112126	21 36	9·887874	18	30
26	44	9·802897	22 57	10·197103	9·915075	22 94	10·084925	10·112178	22 38	9·887822	16	34
30	46	9·802974	23 59	10·197026	9·915203	23 99	10·084797	10·112230	23 40	9·887770	14	30
27	48	9·803050	24 62	10·196950	9·915332	24 103	10·084668	10·112282	24 42	9·887718	12	33
30	50	9·803127	25 64	10·196873	9·915461	25 107	10·084539	10·112334	25 43	9·887666	10	30
28	52	9·803204	26 67	10·196796	9·915590	26 112	10·084410	10·112386	26 45	9·887614	8	32
30	54	9·803281	27 69	10·196719	9·915718	27 116	10·084282	10·112438	27 47	9·887562	6	30
29	56	9·803357	28 72	10·196643	9·915847	28 120	10·084153	10·112490	28 48	9·887510	4	31
30	58	9·803434	29 74	10·196566	9·915976	29 124	10·084024	10·112542	29 50	9·887458	2	30
30	**38**	9·803511	30 77	10·196489	9·916104	30 129	10·083896	10·112594	30 52	9·887406	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

50° — 3ʰ 22ᵐ

LOG. SINES, COSINES, &c.

$2^h\ 38^m$ — 39°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cetang.	Secant	Parts	Cosine	m. s.	′ ″
30	0	9·803511		10·196489	9·916104		10·083896	10·112594		9·887406	22	30
30	2	9·803587	1″ 3	10·196413	9·916233	1″ 4	10·083767	10·112646	1″ 2	9·887354	58	30
31	4	9·803664	2 5	10·196336	9·916362	2 9	10·083638	10·112698	2 3	9·887302	56	29
30	6	9·803740	3 8	10·196260	9·916491	3 13	10·083510	10·112750	3 5	9·887250	54	30
32	8	9·803817	4 10	10·196183	9·916619	4 17	10·083381	10·112802	4 7	9·887198	52	28
30	10	9·803893	5 13	10·196107	9·916748	5 21	10·083252	10·112854	5 9	9·887146	50	30
33	12	9·803970	6 15	10·196030	9·916877	6 26	10·083123	10·112907	6 10	9·887093	48	27
30	14	9·804046	7 18	10·195954	9·917005	7 30	10·082995	10·112959	7 12	9·887041	46	30
34	16	9·804123	8 20	10·195877	9·917134	8 34	10·082866	10·113011	8 14	9·886989	44	26
30	18	9·804199	9 23	10·195801	9·917262	9 39	10·082738	10·113063	9 16	9·886937	42	30
35	20	9·804276	10 25	10·195724	9·917391	10 43	10·082609	10·113115	10 17	9·886885	40	25
30	22	9·804352	11 28	10·195648	9·917520	11 47	10·082480	10·113168	11 19	9·886832	38	30
36	24	9·804428	12 30	10·195572	9·917648	12 51	10·082352	10·113220	12 21	9·886780	36	24
30	26	9·804505	13 33	10·195495	9·917777	13 56	10·082223	10·113272	13 23	9·886728	34	30
37	28	9·804581	14 35	10·195419	9·917906	14 60	10·082094	10·113324	14 24	9·886676	32	23
30	30	9·804657	15 38	10·195343	9·918034	15 64	10·081966	10·113377	15 26	9·886623	30	30
38	32	9·804734	16 40	10·195266	9·918163	16 69	10·081837	10·113429	16 28	9·886571	28	22
30	34	9·804810	17 43	10·195190	9·918291	17 73	10·081709	10·113481	17 30	9·886519	26	30
39	36	9·804886	18 46	10·195114	9·918420	18 77	10·081580	10·113534	18 31	9·886466	24	21
30	38	9·804962	19 48	10·195038	9·918548	19 81	10·081452	10·113586	19 33	9·886414	22	30
40	40	9·805039	20 51	10·194961	9·918677	20 86	10·081323	10·113638	20 35	9·886362	20	20
30	42	9·805115	21 53	10·194885	9·918805	21 90	10·081195	10·113691	21 37	9·886309	18	30
41	44	9·805191	22 56	10·194809	9·918934	22 94	10·081066	10·113743	22 38	9·886257	16	19
30	46	9·805267	23 58	10·194733	9·919063	23 99	10·080937	10·113796	23 40	9·886204	14	30
42	48	9·805343	24 61	10·194657	9·919191	24 103	10·080809	10·113848	24 42	9·886152	12	18
30	50	9·805419	25 63	10·194581	9·919320	25 107	10·080680	10·113901	25 44	9·886099	10	30
43	52	9·805495	26 66	10·194505	9·919448	26 111	10·080552	10·113953	26 45	9·886047	8	17
30	54	9·805571	27 68	10·194429	9·919577	27 116	10·080423	10·114005	27 47	9·885995	6	30
44	56	9·805647	28 71	10·194353	9·919705	28 120	10·080295	10·114058	28 49	9·885942	4	16
30	58	9·805723	29 73	10·194277	9·919834	29 124	10·080166	10·114110	29 50	9·885890	2	30
45	**39**	9·805799	30 76	10·194201	9·919962	30 129	10·080038	10·114163	30 52	9·885837	**21**	15
30	2	9·805875	1 3	10·194125	9·920091	1 4	10·079909	10·114216	1 2	9·885784	58	30
46	4	9·805951	2 5	10·194049	9·920219	2 9	10·079781	10·114268	2 4	9·885732	56	14
30	6	9·806027	3 8	10·193973	9·920348	3 13	10·079652	10·114321	3 5	9·885679	54	30
47	8	9·806103	4 10	10·193897	9·920476	4 17	10·079524	10·114373	4 7	9·885627	52	13
30	10	9·806179	5 13	10·193821	9·920604	5 21	10·079396	10·114426	5 9	9·885574	50	30
48	12	9·806254	6 15	10·193746	9·920733	6 26	10·079267	10·114478	6 11	9·885522	48	12
30	14	9·806330	7 18	10·193670	9·920861	7 30	10·079139	10·114531	7 12	9·885469	46	30
49	16	9·806406	8 20	10·193594	9·920990	8 34	10·079010	10·114584	8 14	9·885416	44	11
30	18	9·806482	9 23	10·193518	9·921118	9 39	10·078882	10·114636	9 16	9·885364	42	30
50	20	9·806557	10 25	10·193443	9·921247	10 43	10·078753	10·114689	10 18	9·885311	40	10
30	22	9·806633	11 28	10·193367	9·921375	11 47	10·078625	10·114742	11 20	9·885258	38	30
51	24	9·806709	12 30	10·193291	9·921503	12 51	10·078497	10·114795	12 21	9·885205	36	9
30	26	9·806785	13 33	10·193215	9·921632	13 56	10·078368	10·114847	13 23	9·885153	34	30
52	28	9·806860	14 35	10·193140	9·921760	14 60	10·078240	10·114900	14 25	9·885100	32	8
30	30	9·806936	15 38	10·193064	9·921889	15 64	10·078111	10·114953	15 26	9·885047	30	30
53	32	9·807011	16 40	10·192989	9·922017	16 68	10·077983	10·115006	16 28	9·884994	28	7
30	34	9·807087	17 43	10·192913	9·922145	17 73	10·077855	10·115058	17 30	9·884942	26	30
54	36	9·807163	18 45	10·192837	9·922274	18 77	10·077726	10·115111	18 32	9·884889	24	6
30	38	9·807238	19 48	10·192762	9·922402	19 81	10·077598	10·115164	19 33	9·884836	22	30
55	40	9·807314	20 50	10·192686	9·922530	20 86	10·077470	10·115217	20 35	9·884783	20	5
30	42	9·807389	21 53	10·192611	9·922659	21 90	10·077341	10·115270	21 37	9·884730	18	30
56	44	9·807465	22 55	10·192535	9·922787	22 94	10·077213	10·115323	22 39	9·884677	16	4
30	46	9·807540	23 58	10·192460	9·922915	23 98	10·077085	10·115375	23 40	9·884625	14	30
57	48	9·807615	24 60	10·192385	9·923044	24 103	10·076956	10·115428	24 42	9·884572	12	3
30	50	9·807691	25 63	10·192309	9·923172	25 107	10·076828	10·115481	25 44	9·884519	10	30
58	52	9·807766	26 65	10·192234	9·923300	26 111	10·076700	10·115534	26 46	9·884466	8	2
30	54	9·807842	27 68	10·192158	9·923429	27 116	10·076571	10·115587	27 48	9·884413	6	30
59	56	9·807917	28 70	10·192083	9·923557	28 120	10·076443	10·115640	28 49	9·884360	4	1
30	58	9·807992	29 73	10·192008	9·923685	29 124	10·076315	10·115693	29 51	9·884307	2	30
60	**40**	9·808067	30 76	10·191933	9·923814	30 128	10·076186	10·115746	30 53	9·884254	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

50° — $3^h\ 20^m$

LOG. SINES, COSINES, &c.

2h 40m — 40°

′ ″	m. s.	Sine	Parts	Cosec	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·808067		10·191933	9·923814		10·076186	10·115746		9·884254	**20**	60
30	2	9·808143	1″ 3	10·191857	9·923942	1″ 4	10·076058	10·115799	1″ 2	9·884201	58	30
1	4	9·808218	2 5	10·191782	9·924070	2 9	10·075930	10·115852	2 4	9·884148	56	59
30	6	9·808293	3 8	10·191707	9·924198	3 13	10·075802	10·115905	3 5	9·884095	54	30
2	8	9·808368	4 10	10·191632	9·924327	4 17	10·075673	10·115958	4 7	9·884042	52	58
30	10	9·808444	5 13	10·191556	9·924455	5 21	10·075545	10·116011	5 9	9·883989	50	30
3	12	9·808519	6 15	10·191481	9·924583	6 26	10·075417	10·116064	6 11	9·883936	48	57
30	14	9·808594	7 18	10·191406	9·924711	7 30	10·075289	10·116117	7 12	9·883883	46	30
4	16	9·808669	8 20	10·191331	9·924840	8 34	10·075160	10·116171	8 14	9·883829	44	56
30	18	9·808744	9 23	10·191256	9·924968	9 38	10·075032	10·116224	9 16	9·883776	42	30
5	20	9·808819	10 25	10·191181	9·925096	10 43	10·074904	10·116277	10 18	9·883723	40	55
30	22	9·808894	11 28	10·191106	9·925224	11 47	10·074776	10·116330	11 19	9·883670	38	30
6	24	9·808969	12 30	10·191031	9·925352	12 51	10·074648	10·116383	12 21	9·883617	36	54
30	26	9·809044	13 33	10·190956	9·925481	13 56	10·074519	10·116436	13 23	9·883564	34	30
7	28	9·809119	14 35	10·190881	9·925609	14 60	10·074391	10·116490	14 25	9·883510	32	53
30	30	9·809194	15 38	10·190806	9·925737	15 64	10·074263	10·116543	15 27	9·883457	30	30
8	32	9·809269	16 40	10·190731	9·925865	16 68	10·074135	10·116596	16 28	9·883404	28	52
30	34	9·809344	17 43	10·190656	9·925993	17 73	10·074007	10·116649	17 30	9·883351	26	30
9	36	9·809419	18 45	10·190581	9·926122	18 77	10·073878	10·116703	18 32	9·883297	24	51
30	38	9·809494	19 48	10·190506	9·926250	19 81	10·073750	10·116756	19 34	9·883244	22	30
10	40	9·809569	20 50	10·190431	9·926378	20 85	10·073622	10·116809	20 35	9·883191	20	50
30	42	9·809643	21 53	10·190357	9·926506	21 90	10·073494	10·116863	21 37	9·883137	18	30
11	44	9·809718	22 55	10·190282	9·926634	22 94	10·073366	10·116916	22 39	9·883084	16	49
30	46	9·809793	23 58	10·190207	9·926762	23 98	10·073238	10·116969	23 41	9·883031	14	30
12	48	9·809868	24 60	10·190132	9·926890	24 102	10·073110	10·117023	24 42	9·882977	12	48
30	50	9·809943	25 63	10·190057	9·927019	25 107	10·072981	10·117076	25 44	9·882924	10	30
13	52	9·810017	26 65	10·189983	9·927147	26 111	10·072853	10·117129	26 46	9·882871	8	47
30	54	9·810092	27 68	10·189908	9·927275	27 115	10·072725	10·117183	27 48	9·882817	6	30
14	56	9·810167	28 70	10·189833	9·927403	28 120	10·072597	10·117236	28 50	9·882764	4	46
30	58	9·810241	29 73	10·189759	9·927531	29 124	10·072469	10·117290	29 51	9·882710	2	30
15	**41**	9·810316	30 75	10·189684	9·927659	30 128	10·072341	10·117343	30 53	9·882657	**19**	45
30	2	9·810390	1 2	10·189610	9·927787	1 4	10·072213	10·117397	1 2	9·882603	58	30
16	4	9·810465	2 5	10·189535	9·927915	2 9	10·072085	10·117450	2 4	9·882550	56	44
30	6	9·810540	3 7	10·189460	9·928043	3 13	10·071957	10·117504	3 5	9·882496	54	30
17	8	9·810614	4 10	10·189386	9·928171	4 17	10·071829	10·117557	4 7	9·882443	52	43
30	10	9·810689	5 12	10·189311	9·928299	5 21	10·071701	10·117611	5 9	9·882389	50	30
18	12	9·810763	6 15	10·189237	9·928427	6 26	10·071573	10·117664	6 11	9·882336	48	42
30	14	9·810838	7 17	10·189162	9·928555	7 30	10·071445	10·117718	7 13	9·882282	46	30
19	16	9·810912	8 20	10·189088	9·928684	8 34	10·071316	10·117771	8 14	9·882229	44	41
30	18	9·810986	9 22	10·189014	9·928812	9 38	10·071188	10·117825	9 16	9·882175	42	30
20	20	9·811061	10 25	10·188939	9·928940	10 43	10·071060	10·117879	10 18	9·882121	40	40
30	22	9·811135	11 27	10·188865	9·929068	11 47	10·070932	10·117932	11 20	9·882068	38	30
21	24	9·811210	12 30	10·188790	9·929196	12 51	10·070804	10·117986	12 21	9·882014	36	39
30	26	9·811284	13 32	10·188716	9·929324	13 55	10·070676	10·118040	13 23	9·881960	34	30
22	28	9·811358	14 35	10·188642	9·929452	14 60	10·070548	10·118093	14 25	9·881907	32	38
30	30	9·811433	15 37	10·188567	9·929580	15 64	10·070420	10·118147	15 27	9·881853	30	30
23	32	9·811507	16 40	10·188493	9·929708	16 68	10·070292	10·118201	16 29	9·881799	28	37
30	34	9·811581	17 42	10·188419	9·929836	17 73	10·070164	10·118254	17 30	9·881746	26	30
24	36	9·811655	18 45	10·188345	9·929964	18 77	10·070036	10·118308	18 32	9·881692	24	36
30	38	9·811730	19 47	10·188270	9·930092	19 81	10·069908	10·118362	19 34	9·881638	22	30
25	40	9·811804	20 50	10·188196	9·930220	20 85	10·069780	10·118416	20 36	9·881584	20	35
30	42	9·811878	21 52	10·188122	9·930348	21 90	10·069652	10·118470	21 38	9·881530	18	30
26	44	9·811952	22 55	10·188048	9·930475	22 94	10·069525	10·118523	22 39	9·881477	16	34
30	46	9·812026	23 57	10·187974	9·930603	23 98	10·069397	10·118577	23 41	9·881423	14	30
27	48	9·812100	24 60	10·187900	9·930731	24 102	10·069269	10·118631	24 43	9·881369	12	33
30	50	9·812174	25 62	10·187826	9·930859	25 107	10·069141	10·118685	25 45	9·881315	10	30
28	52	9·812248	26 65	10·187752	9·930987	26 111	10·069013	10·118739	26 47	9·881261	8	32
30	54	9·812322	27 67	10·187678	9·931115	27 115	10·068885	10·118793	27 48	9·881207	6	30
29	56	9·812396	28 70	10·187604	9·931243	28 119	10·068757	10·118847	28 50	9·881153	4	31
30	58	9·812470	29 72	10·187530	9·931371	29 124	10·068629	10·118901	29 52	9·881099	2	30
30	**42**	9·812544	30 74	10·187456	9·931499	30 128	10·068501	10·118954	30 54	9·881046	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

49° — 3h 18m

LOG. SINES, COSINES, &c.

2^h 42^m 40°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
30	0	9·812544		10·187456	9·931499		10·068501	10·118954		9·881046	18	30
30	2	9·812618	1″ 2	10·187382	9·931627	1″ 4	10·068373	10·119008	1″ 2	9·880992	58	30
31	4	9·812692	2 5	10·187308	9·931755	2 9	10·068245	10·119062	2 4	9·880938	56	29
30	6	9·812766	3 7	10·187234	9·931883	3 13	10·068117	10·119116	3 5	9·880884	54	30
32	8	9·812840	4 10	10·187160	9·932010	4 17	10·067990	10·119170	4 7	9·880830	52	28
30	10	9·812914	5 12	10·187086	9·932138	5 21	10·067862	10·119224	5 9	9·880776	50	30
33	12	9·812988	6 15	10·187012	9·932266	6 26	10·067734	10·119278	6 11	9·880722	48	27
30	14	9·813062	7 17	10·186938	9·932394	7 30	10·067606	10·119333	7 13	9·880667	46	10
34	16	9·813135	8 20	10·186865	9·932522	8 34	10·067478	10·119387	8 14	9·880613	44	26
30	18	9·813209	9 22	10·186791	9·932650	9 38	10·067350	10·119441	9 16	9·880559	42	30
35	20	9·813283	10 24	10·186717	9·932778	10 43	10·067222	10·119495	10 18	9·880505	40	25
30	22	9·813357	11 27	10·186643	9·932906	11 47	10·067094	10·119549	11 20	9·880451	38	30
36	24	9·813430	12 29	10·186570	9·933033	12 51	10·066967	10·119603	12 22	9·880397	36	24
30	26	9·813504	13 32	10·186496	9·933161	13 55	10·066839	10·119657	13 24	9·880343	34	30
37	28	9·813578	14 34	10·186422	9·933289	14 60	10·066711	10·119711	14 25	9·880289	32	23
30	30	9·813651	15 37	10·186349	9·933417	15 64	10·066583	10·119766	15 27	9·880234	30	30
38	32	9·813725	16 39	10·186275	9·933545	16 68	10·066455	10·119820	16 29	9·880180	28	22
30	34	9·813799	17 42	10·186201	9·933672	17 72	10·066328	10·119874	17 31	9·880126	26	30
39	36	9·813872	18 44	10·186128	9·933800	18 77	10·066200	10·119928	18 32	9·880072	24	21
30	38	9·813946	19 47	10·186054	9·933928	19 81	10·066072	10·119982	19 34	9·880018	22	30
40	40	9·814019	20 49	10·185981	9·934056	20 85	10·065944	10·120037	20 36	9·879963	20	20
30	42	9·814093	21 51	10·185907	9·934184	21 89	10·065816	10·120091	21 38	9·879909	18	30
41	44	9·814166	22 54	10·185834	9·934311	22 94	10·065689	10·120145	22 40	9·879855	16	19
30	46	9·814240	23 56	10·185760	9·934439	23 98	10·065561	10·120200	23 42	9·879800	14	30
42	48	9·814313	24 59	10·185687	9·934567	24 102	10·065433	10·120254	24 43	9·879746	12	18
30	50	9·814387	25 61	10·185613	9·934695	25 106	10·065305	10·120308	25 45	9·879692	10	30
43	52	9·814460	26 64	10·185540	9·934822	26 111	10·065178	10·120363	26 47	9·879637	8	17
30	54	9·814533	27 66	10·185467	9·934950	27 115	10·065050	10·120417	27 49	9·879583	6	30
44	56	9·814607	28 69	10·185393	9·935078	28 119	10·064922	10·120471	28 51	9·879529	4	16
30	58	9·814680	29 71	10·185320	9·935206	29 124	10·064794	10·120526	29 52	9·879474	2	30
45	**43**	9·814753	30 74	10·185247	9·935333	30 128	10·064667	10·120580	30 54	9·879420	**17**	15
30	2	9·814827	1 2	10·185173	9·935461	1 4	10·064539	10·120635	1 2	9·879365	58	30
46	4	9·814900	2 5	10·185100	9·935589	2 9	10·064411	10·120689	2 4	9·879311	56	14
30	6	9·814973	3 7	10·185027	9·935717	3 13	10·064283	10·120743	3 5	9·879257	54	30
47	8	9·815046	4 10	10·184954	9·935844	4 17	10·064156	10·120798	4 7	9·879202	52	13
30	10	9·815120	5 12	10·184880	9·935972	5 21	10·064028	10·120852	5 9	9·879148	50	30
48	12	9·815193	6 15	10·184807	9·936100	6 26	10·063900	10·120907	6 11	9·879093	48	12
30	14	9·815266	7 17	10·184734	9·936227	7 30	10·063773	10·120961	7 13	9·879039	46	50
49	16	9·815339	8 20	10·184661	9·936355	8 34	10·063645	10·121016	8 15	9·878984	44	11
30	18	9·815412	9 22	10·184588	9·936483	9 38	10·063517	10·121071	9 16	9·878929	42	30
50	20	9·815485	10 24	10·184515	9·936611	10 43	10·063389	10·121125	10 18	9·878875	40	10
30	22	9·815558	11 27	10·184442	9·936738	11 47	10·063262	10·121180	11 20	9·878820	38	30
51	24	9·815632	12 29	10·184368	9·936866	12 51	10·063134	10·121234	12 22	9·878766	36	9
30	26	9·815705	13 32	10·184295	9·936994	13 55	10·063006	10·121289	13 24	9·878711	34	30
52	28	9·815778	14 34	10·184222	9·937121	14 60	10·062879	10·121344	14 25	9·878656	32	8
30	30	9·815851	15 36	10·184149	9·937249	15 64	10·062751	10·121398	15 27	9·878602	30	30
53	32	9·815924	16 39	10·184076	9·937377	16 68	10·062623	10·121453	16 29	9·878547	28	7
30	34	9·815996	17 41	10·184004	9·937504	17 72	10·062496	10·121508	17 31	9·878492	26	30
54	36	9·816069	18 44	10·183931	9·937632	18 77	10·062368	10·121562	18 33	9·878438	24	6
30	38	9·816142	19 46	10·183858	9·937759	19 81	10·062241	10·121617	19 35	9·878383	22	30
55	40	9·816215	20 49	10·183785	9·937887	20 85	10·062113	10·121672	20 36	9·878328	20	5
30	42	9·816288	21 51	10·183712	9·938015	21 89	10·061985	10·121727	21 38	9·878273	18	30
56	44	9·816361	22 54	10·183639	9·938142	22 94	10·061858	10·121781	22 40	9·878219	16	4
30	46	9·816434	23 56	10·183566	9·938270	23 98	10·061730	10·121836	23 42	9·878164	14	30
57	48	9·816507	24 58	10·183493	9·938398	24 102	10·061602	10·121891	24 44	9·878109	12	3
30	50	9·816579	25 61	10·183421	9·938525	25 106	10·061475	10·121946	25 46	9·878054	10	30
58	52	9·816652	26 63	10·183348	9·938653	26 111	10·061347	10·122001	26 47	9·877999	8	2
30	54	9·816725	27 66	10·183275	9·938780	27 115	10·061220	10·122055	27 49	9·877945	6	30
59	56	9·816798	28 68	10·183202	9·938908	28 119	10·061092	10·122110	28 51	9·877890	4	1
30	58	9·816870	29 70	10·183130	9·939035	29 123	10·060965	10·122165	29 53	9·877835	2	30
60	**44**	9·816943	30 73	10·183057	9·939163	30 128	10·060837	10·122220	30 55	9·877780	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

49° 3^h 16^m

LOG. SINES, COSINES, &c.

2ʰ 44ᵐ					41°							
′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·816943		10·183057	9·939163		10·060837	10·122220		9·877780	**16**	60
30	2	9·817016	1″ 2	10·182984	9·939291	1″ 4	10·060709	10·122275	1″ 2	9·877725	58	30
1	4	9·817088	2 5	10·182912	9·939418	2 8	10·060582	10·122330	2 4	9·877670	56	59
30	6	9·817161	3 7	10·182839	9·939546	3 13	10·060454	10·122385	3 5	9·877615	54	30
2	8	9·817233	4 10	10·182767	9·939673	4 17	10·060327	10·122440	4 7	9·877560	52	58
30	10	9·817306	5 12	10·182694	9·939801	5 21	10·060199	10·122495	5 9	9·877505	50	30
3	12	9·817379	6 14	10·182621	9·939928	6 25	10·060072	10·122550	6 11	9·877450	48	57
30	14	9·817451	7 17	10·182549	9·940056	7 30	10·059944	10·122605	7 13	9·877395	46	30
4	16	9·817524	8 19	10·182476	9·940183	8 34	10·059817	10·122660	8 15	9·877340	44	56
30	18	9·817596	9 22	10·182404	9·940311	9 38	10·059689	10·122715	9 16	9·877285	42	30
5	20	9·817668	10 24	10·182332	9·940439	10 42	10·059561	10·122770	10 18	9·877230	40	55
30	22	9·817741	11 27	10·182259	9·940566	11 47	10·059434	10·122825	11 20	9·877175	38	30
6	24	9·817813	12 29	10·182187	9·940694	12 51	10·059306	10·122880	12 22	9·877120	36	54
30	26	9·817886	13 32	10·182114	9·940821	13 55	10·059179	10·122935	13 24	9·877065	34	30
7	28	9·817958	14 34	10·182042	9·940949	14 59	10·059051	10·122990	14 26	9·877010	32	53
30	30	9·818030	15 36	10·181970	9·941076	15 64	10·058924	10·123046	15 27	9·876954	30	30
8	32	9·818103	16 39	10·181897	9·941204	16 68	10·058796	10·123101	16 29	9·876899	28	52
30	34	9·818175	17 41	10·181825	9·941331	17 72	10·058669	10·123156	17 31	9·876844	26	30
9	36	9·818247	18 43	10·181753	9·941459	18 76	10·058541	10·123211	18 33	9·876789	24	51
30	38	9·818320	19 46	10·181680	9·941586	19 81	10·058414	10·123266	19 35	9·876734	22	30
10	40	9·818392	20 48	10·181608	9·941713	20 85	10·058287	10·123322	20 37	9·876678	20	50
30	42	9·818464	21 51	10·181536	9·941841	21 89	10·058159	10·123377	21 38	9·876623	18	30
11	44	9·818536	22 53	10·181464	9·941968	22 93	10·058032	10·123432	22 40	9·876568	16	49
30	46	9·818609	23 56	10·181391	9·942096	23 98	10·057904	10·123487	23 42	9·876513	14	30
12	48	9·818681	24 58	10·181319	9·942223	24 102	10·057777	10·123543	24 44	9·876457	12	48
30	50	9·818753	25 61	10·181247	9·942351	25 106	10·057649	10·123598	25 46	9·876402	10	30
13	52	9·818825	26 63	10·181175	9·942478	26 110	10·057522	10·123653	26 48	9·876347	8	47
30	54	9·818897	27 65	10·181103	9·942606	27 115	10·057394	10·123709	27 49	9·876291	6	30
14	56	9·818969	28 68	10·181031	9·942733	28 119	10·057267	10·123764	28 51	9·876236	4	46
30	58	9·819041	29 70	10·180959	9·942861	29 123	10·057139	10·123819	29 53	9·876181	2	30
15	**45**	9·819113	30 72	10·180887	9·942988	30 127	10·057012	10·123875	30 55	9·876125	**15**	45
30	2	9·819185	1 2	10·180815	9·943115	1 4	10·056885	10·123930	1 2	9·876070	58	30
16	4	9·819257	2 5	10·180743	9·943243	2 8	10·056757	10·123986	2 4	9·876014	56	44
30	6	9·819329	3 7	10·180671	9·943370	3 13	10·056630	10·124041	3 6	9·875959	54	30
17	8	9·819401	4 10	10·180599	9·943498	4 17	10·056502	10·124096	4 7	9·875904	52	43
30	10	9·819473	5 12	10·180527	9·943625	5 21	10·056375	10·124152	5 9	9·875848	50	30
18	12	9·819545	6 14	10·180455	9·943752	6 25	10·056248	10·124207	6 11	9·875793	48	42
30	14	9·819617	7 17	10·180383	9·943880	7 30	10·056120	10·124263	7 13	9·875737	46	30
19	16	9·819689	8 19	10·180311	9·944007	8 34	10·055993	10·124318	8 15	9·875682	44	41
30	18	9·819761	9 22	10·180239	9·944135	9 38	10·055865	10·124374	9 17	9·875626	42	30
20	20	9·819832	10 24	10·180168	9·944262	10 42	10·055738	10·124429	10 19	9·875571	40	40
30	22	9·819904	11 26	10·180096	9·944389	11 47	10·055611	10·124485	11 20	9·875515	38	30
21	24	9·819976	12 29	10·180024	9·944517	12 51	10·055483	10·124541	12 22	9·875459	36	39
30	26	9·820048	13 31	10·179952	9·944644	13 55	10·055356	10·124596	13 24	9·875404	34	30
22	28	9·820120	14 34	10·179880	9·944771	14 59	10·055229	10·124652	14 26	9·875348	32	38
30	30	9·820191	15 36	10·179809	9·944899	15 64	10·055101	10·124707	15 28	9·875293	30	30
23	32	9·820263	16 38	10·179737	9·945026	16 68	10·054974	10·124763	16 30	9·875237	28	37
30	34	9·820335	17 41	10·179665	9·945153	17 72	10·054847	10·124819	17 31	9·875181	26	30
24	36	9·820406	18 43	10·179594	9·945281	18 76	10·054719	10·124874	18 33	9·875126	24	36
30	38	9·820478	19 46	10·179522	9·945408	19 81	10·054592	10·124930	19 35	9·875070	22	30
25	40	9·820550	20 48	10·179450	9·945535	20 85	10·054465	10·124986	20 37	9·875014	20	35
30	42	9·820621	21 50	10·179379	9·945663	21 89	10·054337	10·125042	21 39	9·874958	18	30
26	44	9·820693	22 53	10·179307	9·945790	22 93	10·054210	10·125097	22 41	9·874903	16	34
30	46	9·820764	23 55	10·179236	9·945917	23 98	10·054083	10·125153	23 43	9·874847	14	30
27	48	9·820836	24 57	10·179164	9·946045	24 102	10·053955	10·125209	24 45	9·874791	12	33
30	50	9·820907	25 60	10·179093	9·946172	25 106	10·053828	10·125265	25 46	9·874735	10	30
28	52	9·820979	26 62	10·179021	9·946299	26 110	10·053701	10·125320	26 48	9·874680	8	32
30	54	9·821050	27 65	10·178950	9·946427	27 115	10·053573	10·125376	27 50	9·874624	6	30
29	56	9·821122	28 67	10·178878	9·946554	28 119	10·053446	10·125432	28 52	9·874568	4	31
30	58	9·821193	29 69	10·178807	9·946681	29 123	10·053319	10·125488	29 54	9·874512	2	30
30	**46**	9·821265	30 72	10·178735	9·946808	30 127	10·053192	10·125544	30 56	9·874456	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″
					48°					3ʰ 14ᵐ		

LOG. SINES, COSINES, &c.

$2^h\ 44^m$ 41°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
30	0	9·821265		10·178735	9·946808		10·053192	10·125544		9·874456	14	30
30	2	9·821336	1″ 2	10·178664	9·946936	1″ 4	10·053064	10·125600	1″ 2	9·874400	58	30
31	4	9·821407	2 5	10·178593	9·947063	2 8	10·052937	10·125656	2 4	9·874344	56	29
30	6	9·821479	3 7	10·178521	9·947190	3 13	10·052810	10·125712	3 6	9·874288	54	30
32	8	9·821550	4 10	10·178450	9·947318	4 17	10·052682	10·125768	4 7	9·874232	52	28
30	10	9·821621	5 12	10·178379	9·947445	5 21	10·052555	10·125823	5 9	9·874177	50	30
33	12	9·821693	6 14	10·178307	9·947572	6 25	10·052428	10·125879	6 11	9·874121	48	27
30	14	9·821764	7 17	10·178236	9·947699	7 30	10·052301	10·125935	7 13	9·874065	46	30
34	16	9·821835	8 19	10·178165	9·947827	8 34	10·052173	10·125991	8 15	9·874009	44	26
30	18	9·821906	9 21	10·178094	9·947954	9 38	10·052046	10·126047	9 17	9·873953	42	30
35	20	9·821977	10 24	10·178023	9·948081	10 42	10·051919	10·126104	10 19	9·873896	40	25
30	22	9·822049	11 26	10·177951	9·948208	11 47	10·051792	10·126160	11 21	9·873840	38	30
36	24	9·822120	12 28	10·177880	9·948335	12 51	10·051665	10·126216	12 22	9·873784	36	24
30	26	9·822191	13 31	10·177809	9·948463	13 55	10·051537	10·126272	13 24	9·873728	34	30
37	28	9·822262	14 33	10·177738	9·948590	14 59	10·051410	10·126328	14 26	9·873672	32	23
30	30	9·822333	15 36	10·177667	9·948717	15 64	10·051283	10·126384	15 28	9·873616	30	30
38	32	9·822404	16 38	10·177596	9·948844	16 68	10·051156	10·126440	16 30	9·873560	28	22
30	34	9·822475	17 40	10·177525	9·948972	17 72	10·051028	10·126496	17 32	9·873504	26	30
39	36	9·822546	18 43	10·177454	9·949099	18 76	10·050901	10·126552	18 34	9·873448	24	21
30	38	9·822617	19 45	10·177383	9·949226	19 81	10·050774	10·126609	19 36	9·873391	22	30
40	40	9·822688	20 47	10·177312	9·949353	20 85	10·050647	10·126665	20 37	9·873335	20	20
30	42	9·822759	21 50	10·177241	9·949480	21 89	10·050520	10·126721	21 39	9·873279	18	30
41	44	9·822830	22 52	10·177170	9·949608	22 93	10·050392	10·126777	22 41	9·873223	16	19
30	46	9·822901	23 55	10·177099	9·949735	23 98	10·050265	10·126834	23 43	9·873166	14	30
42	48	9·822972	24 57	10·177028	9·949862	24 102	10·050138	10·126890	24 45	9·873110	12	18
30	50	9·823043	25 59	10·176957	9·949989	25 106	10·050011	10·126946	25 47	9·873054	10	30
43	52	9·823114	26 62	10·176886	9·950116	26 110	10·049884	10·127002	26 49	9·872998	8	17
30	54	9·823185	27 64	10·176815	9·950243	27 114	10·049757	10·127059	27 50	9·872941	6	30
44	56	9·823255	28 66	10·176745	9·950371	28 119	10·049629	10·127115	28 52	9·872885	4	16
30	58	9·823326	29 69	10·176674	9·950498	29 123	10·049502	10·127171	29 54	9·872829	2	30
45	**47**	9·823397	30 71	10·176603	9·950625	30 127	10·049375	10·127228	30 56	9·872772	**13**	15
30	2	9·823468	1 2	10·176532	9·950752	1 4	10·049248	10·127284	1 2	9·872716	58	30
46	4	9·823539	2 5	10·176461	9·950879	2 8	10·049121	10·127341	2 4	9·872659	56	14
30	6	9·823609	3 7	10·176391	9·951006	3 13	10·048994	10·127397	3 6	9·872603	54	30
47	8	9·823680	4 9	10·176320	9·951133	4 17	10·048867	10·127453	4 8	9·872547	52	13
30	10	9·823751	5 12	10·176249	9·951261	5 21	10·048739	10·127510	5 9	9·872490	50	30
48	12	9·823821	6 14	10·176179	9·951388	6 25	10·048612	10·127566	6 11	9·872434	48	12
30	14	9·823892	7 16	10·176108	9·951515	7 30	10·048485	10·127623	7 13	9·872377	46	30
49	16	9·823963	8 19	10·176037	9·951642	8 34	10·048358	10·127679	8 15	9·872321	44	11
30	18	9·824033	9 21	10·175967	9·951769	9 38	10·048231	10·127736	9 17	9·872264	42	30
50	20	9·824104	10 23	10·175896	9·951896	10 42	10·048104	10·127792	10 19	9·872208	40	10
30	22	9·824174	11 26	10·175826	9·952023	11 47	10·047977	10·127849	11 21	9·872151	38	30
51	24	9·824245	12 28	10·175755	9·952150	12 51	10·047850	10·127905	12 23	9·872095	36	9
30	26	9·824315	13 30	10·175685	9·952277	13 55	10·047723	10·127962	13 25	9·872038	34	30
52	28	9·824386	14 33	10·175614	9·952405	14 59	10·047595	10·128019	14 26	9·871981	32	8
30	30	9·824456	15 35	10·175544	9·952532	15 64	10·047468	10·128075	15 28	9·871925	30	30
53	32	9·824527	16 37	10·175473	9·952659	16 68	10·047341	10·128132	16 30	9·871868	28	7
30	34	9·824597	17 40	10·175403	9·952786	17 72	10·047214	10·128189	17 32	9·871811	26	30
54	36	9·824668	18 42	10·175332	9·952913	18 76	10·047087	10·128245	18 34	9·871755	24	6
30	38	9·824738	19 44	10·175262	9·953040	19 80	10·046960	10·128302	19 36	9·871698	22	30
55	40	9·824808	20 47	10·175192	9·953167	20 85	10·046833	10·128359	20 38	9·871641	20	5
30	42	9·824879	21 49	10·175121	9·953294	21 89	10·046706	10·128415	21 40	9·871585	18	30
56	44	9·824949	22 51	10·175051	9·953421	22 93	10·046579	10·128472	22 42	9·871528	16	4
30	46	9·825019	23 54	10·174981	9·953548	23 97	10·046452	10·128529	23 43	9·871471	14	30
57	48	9·825090	24 56	10·174910	9·953675	24 102	10·046325	10·128586	24 45	9·871414	12	3
30	50	9·825160	25 58	10·174840	9·953802	25 106	10·046198	10·128642	25 47	9·871358	10	30
58	52	9·825230	26 61	10·174770	9·953929	26 110	10·046071	10·128699	26 49	9·871301	8	2
30	54	9·825300	27 63	10·174700	9·954056	27 114	10·045944	10·128756	27 51	9·871244	6	30
59	56	9·825371	28 66	10·174629	9·954183	28 118	10·045817	10·128813	28 53	9·871187	4	1
30	58	9·825441	29 68	10·174559	9·954310	29 123	10·045690	10·128870	29 55	9·871130	2	30
60	**48**	9·825511	30 71	10·174489	9·954437	30 127	10·045563	10·128927	30 57	9·871073	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

48° $3^h\ 12^m$

LOG. SINES, COSINES, &c.

2h 48m — 42°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·825511		10·174489	9·954437		10·045563	10·128927		9·871073	12	60
30	2	9·825581	1″ 2	10·174419	9·954564	1″ 4	10·045436	10·128983	1″ 2	9·871017	58	30
1	4	9·825651	2 5	10·174349	9·954691	2 8	10·045309	10·129040	2 4	9·870960	56	59
30	6	9·825721	3 7	10·174279	9·954819	3 13	10·045181	10·129097	3 6	9·870903	54	30
2	8	9·825791	4 9	10·174209	9·954946	4 17	10·045054	10·129154	4 8	9·870846	52	58
30	10	9·825861	5 12	10·174139	9·955073	5 21	10·044927	10·129211	5 10	9·870789	50	30
3	12	9·825931	6 14	10·174069	9·955200	6 25	10·044800	10·129268	6 11	9·870732	48	57
30	14	9·826001	7 16	10·173999	9·955327	7 30	10·044673	10·129325	7 13	9·870675	46	30
4	16	9·826071	8 19	10·173929	9·955454	8 34	10·044546	10·129382	8 15	9·870618	44	56
30	18	9·826141	9 21	10·173859	9·955581	9 38	10·044419	10·129439	9 17	9·870561	42	30
5	20	9·826211	10 23	10·173789	9·955708	10 42	10·044292	10·129496	10 19	9·870504	40	55
30	22	9·826281	11 26	10·173719	9·955835	11 47	10·044165	10·129553	11 21	9·870447	38	30
6	24	9·826351	12 28	10·173649	9·955961	12 51	10·044039	10·129610	12 23	9·870390	36	54
30	26	9·826421	13 30	10·173579	9·956088	13 55	10·043912	10·129667	13 25	9·870333	34	30
7	28	9·826491	14 33	10·173509	9·956215	14 59	10·043785	10·129724	14 27	9·870276	32	53
30	30	9·826561	15 35	10·173439	9·956342	15 63	10·043658	10·129782	15 29	9·870218	30	30
8	32	9·826631	16 37	10·173369	9·956469	16 68	10·043531	10·129839	16 30	9·870161	28	52
30	34	9·826701	17 40	10·173299	9·956596	17 72	10·043404	10·129896	17 32	9·870104	26	30
9	36	9·826770	18 42	10·173230	9·956723	18 76	10·043277	10·129953	18 34	9·870047	24	51
30	38	9·826840	19 44	10·173160	9·956850	19 80	10·043150	10·130010	19 36	9·869990	22	30
10	40	9·826910	20 47	10·173090	9·956977	20 85	10·043023	10·130067	20 38	9·869933	20	50
30	42	9·826980	21 49	10·173020	9·957104	21 89	10·042896	10·130125	21 40	9·869875	18	30
11	44	9·827049	22 51	10·172951	9·957231	22 93	10·042769	10·130182	22 42	9·869818	16	49
30	46	9·827119	23 54	10·172881	9·957358	23 97	10·042642	10·130239	23 44	9·869761	14	30
12	48	9·827189	24 56	10·172811	9·957485	24 102	10·042515	10·130296	24 46	9·869704	12	48
30	50	9·827258	25 58	10·172742	9·957612	25 106	10·042388	10·130354	25 48	9·869646	10	30
13	52	9·827328	26 61	10·172672	9·957739	26 110	10·042261	10·130411	26 49	9·869589	8	47
30	54	9·827398	27 63	10·172602	9·957866	27 114	10·042134	10·130468	27 51	9·869532	6	30
14	56	9·827467	28 65	10·172533	9·957993	28 118	10·042007	10·130526	28 53	9·869474	4	46
30	58	9·827537	29 68	10·172463	9·958120	29 123	10·041880	10·130583	29 55	9·869417	2	30
15	49	9·827606	30 70	10·172394	9·958247	30 127	10·041753	10·130640	30 57	9·869360	11	45
30	2	9·827676	1 2	10·172324	9·958373	1 4	10·041627	10·130698	1 2	9·869302	58	30
16	4	9·827745	2 5	10·172255	9·958500	2 8	10·041500	10·130755	2 4	9·869245	56	44
30	6	9·827815	3 7	10·172185	9·958627	3 13	10·041373	10·130812	3 6	9·869188	54	30
17	8	9·827884	4 9	10·172116	9·958754	4 17	10·041246	10·130870	4 8	9·869130	52	43
30	10	9·827954	5 12	10·172046	9·958881	5 21	10·041119	10·130927	5 10	9·869073	50	30
18	12	9·828023	6 14	10·171977	9·959008	6 25	10·040992	10·130985	6 12	9·869015	48	42
30	14	9·828093	7 16	10·171907	9·959135	7 30	10·040865	10·131042	7 13	9·868958	46	30
19	16	9·828162	8 19	10·171838	9·959262	8 34	10·040738	10·131100	8 15	9·868900	44	41
30	18	9·828231	9 21	10·171769	9·959389	9 38	10·040611	10·131157	9 17	9·868843	42	30
20	20	9·828301	10 23	10·171699	9·959516	10 42	10·040484	10·131215	10 19	9·868785	40	40
30	22	9·828370	11 26	10·171630	9·959642	11 47	10·040358	10·131272	11 21	9·868728	38	30
21	24	9·828439	12 28	10·171561	9·959769	12 51	10·040231	10·131330	12 23	9·868670	36	39
30	26	9·828509	13 30	10·171491	9·959896	13 55	10·040104	10·131388	13 25	9·868612	34	30
22	28	9·828578	14 33	10·171422	9·960023	14 59	10·039977	10·131445	14 27	9·868555	32	38
30	30	9·828647	15 35	10·171353	9·960150	15 63	10·039850	10·131503	15 29	9·868497	30	30
23	32	9·828716	16 37	10·171284	9·960277	16 68	10·039723	10·131560	16 31	9·868440	28	37
30	34	9·828786	17 40	10·171214	9·960404	17 72	10·039596	10·131618	17 33	9·868382	26	30
24	36	9·828855	18 42	10·171145	9·960530	18 76	10·039470	10·131676	18 35	9·868324	24	36
30	38	9·828924	19 44	10·171076	9·960657	19 80	10·039343	10·131733	19 36	9·868267	22	30
25	40	9·828993	20 46	10·171007	9·960784	20 85	10·039216	10·131791	20 38	9·868209	20	35
30	42	9·829062	21 49	10·170938	9·960911	21 89	10·039089	10·131849	21 40	9·868151	18	30
26	44	9·829131	22 51	10·170869	9·961038	22 93	10·038962	10·131907	22 42	9·868093	16	34
30	46	9·829200	23 53	10·170800	9·961165	23 97	10·038835	10·131964	23 44	9·868036	14	30
27	48	9·829269	24 55	10·170731	9·961292	24 102	10·038708	10·132022	24 46	9·867978	12	33
30	50	9·829338	25 58	10·170662	9·961418	25 106	10·038582	10·132080	25 48	9·867920	10	30
28	52	9·829407	26 60	10·170593	9·961545	26 110	10·038455	10·132138	26 50	9·867862	8	32
30	54	9·829476	27 62	10·170524	9·961672	27 114	10·038328	10·132196	27 52	9·867804	6	30
29	56	9·829545	28 65	10·170455	9·961799	28 118	10·038201	10·132253	28 54	9·867747	4	31
30	58	9·829614	29 67	10·170386	9·961926	29 123	10·038074	10·132311	29 56	9·867689	2	30
30	50	9·829683	30 69	10·170317	9·962052	30 127	10·037948	10·132369	30 58	9·867631	0	30
′ ″	m. s.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

47° — 3h 10m

LOG. SINES, COSINES, &c.

$2^h\ 50^m$ 42°

′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
30	0	9·829683		10·170317	9·962052		10·037948	10·132369		9·867631	**10**	30
30	2	9·829752	1″ 2	10·170248	9·962179	1″ 4	10·037821	10·132427	1″ 2	9·867573	58	30
31	4	9·829821	2 5	10·170179	9·962306	2 8	10·037694	10·132485	2 4	9·867515	56	29
30	6	9·829890	3 7	10·170110	9·962433	3 13	10·037567	10·132543	3 6	9·867457	54	30
32	8	9·829959	4 9	10·170041	9·962560	4 17	10·037440	10·132601	4 8	9·867399	52	28
30	10	9·830028	5 12	10·169972	9·962686	5 21	10·037314	10·132659	5 10	9·867341	50	30
33	12	9·830097	6 14	10·169903	9·962813	6 25	10·037187	10·132717	6 12	9·867283	48	27
30	14	9·830165	7 16	10·169835	9·962940	7 30	10·037060	10·132775	7 14	9·867225	46	30
34	16	9·830234	8 19	10·169766	9·963067	8 34	10·036933	10·132833	8 15	9·867167	44	26
30	18	9·830303	9 21	10·169697	9·963194	9 38	10·036806	10·132891	9 17	9·867109	42	30
35	20	9·830372	10 23	10·169628	9·963320	10 42	10·036680	10·132949	10 19	9·867051	40	25
30	22	9·830440	11 25	10·169560	9·963447	11 46	10·036553	10·133007	11 21	9·866993	38	30
36	24	9·830509	12 27	10·169491	9·963574	12 51	10·036426	10·133065	12 23	9·866935	36	24
30	26	9·830578	13 30	10·169422	9·963701	13 55	10·036299	10·133123	13 25	9·866877	34	30
37	28	9·830646	14 32	10·169354	9·963828	14 59	10·036172	10·133181	14 27	9·866819	32	23
30	30	9·830715	15 34	10·169285	9·963954	15 63	10·036046	10·133239	15 29	9·866761	30	30
38	32	9·830784	16 36	10·169216	9·964081	16 68	10·035919	10·133297	16 31	9·866703	28	22
30	34	9·830852	17 39	10·169148	9·964208	17 72	10·035792	10·133356	17 33	9·866644	26	30
39	36	9·830921	18 41	10·169079	9·964335	18 76	10·035665	10·133414	18 35	9·866586	24	21
30	38	9·830989	19 43	10·169011	9·964461	19 80	10·035539	10·133472	19 37	9·866528	22	30
40	40	9·831058	20 46	10·168942	9·964588	20 84	10·035412	10·133530	20 39	9·866470	20	20
30	42	9·831127	21 48	10·168873	9·964715	21 89	10·035285	10·133588	21 41	9·866412	18	30
41	44	9·831195	22 50	10·168805	9·964842	22 93	10·035158	10·133647	22 43	9·866353	16	19
30	46	9·831263	23 52	10·168736	9·964968	23 97	10·035032	10·133705	23 44	9·866295	14	30
42	48	9·831332	24 55	10·168668	9·965095	24 101	10·034905	10·133763	24 46	9·866237	12	18
30	50	9·831400	25 57	10·168600	9·965222	25 105	10·034778	10·133821	25 48	9·866179	10	30
43	52	9·831469	26 59	10·168531	9·965349	26 110	10·034651	10·133880	26 50	9·866120	8	17
30	54	9·831537	27 62	10·168463	9·965475	27 114	10·034525	10·133938	27 52	9·866062	6	30
44	56	9·831606	28 64	10·168394	9·965602	28 118	10·034398	10·133996	28 54	9·866004	4	16
30	58	9·831674	29 66	10·168326	9·965729	29 122	10·034271	10·134055	29 56	9·865945	2	30
45	**51**	9·831742	30 69	10·168258	9·965855	30 127	10·034145	10·134113	30 58	9·865887	**9**	15
30	2	9·831811	1 2	10·168189	9·965982	1 4	10·034018	10·134172	1 2	9·865828	58	30
46	4	9·831879	2 5	10·168121	9·966109	2 8	10·033891	10·134230	2 4	9·865770	56	14
30	6	9·831947	3 7	10·168053	9·966236	3 13	10·033764	10·134288	3 6	9·865712	54	30
47	8	9·832015	4 9	10·167985	9·966362	4 17	10·033638	10·134347	4 8	9·865653	52	13
30	10	9·832084	5 12	10·167916	9·966489	5 21	10·033511	10·134405	5 10	9·865595	50	30
48	12	9·832152	6 14	10·167848	9·966616	6 25	10·033384	10·134464	6 12	9·865536	48	12
30	14	9·832220	7 16	10·167780	9·966742	7 30	10·033258	10·134522	7 14	9·865478	46	30
49	16	9·832288	8 19	10·167712	9·966869	8 34	10·033131	10·134581	8 16	9·865419	44	11
30	18	9·832356	9 21	10·167643	9·966996	9 38	10·033004	10·134639	9 18	9·865361	42	30
50	20	9·832425	10 23	10·167575	9·967123	10 42	10·032877	10·134698	10 20	9·865302	40	10
30	22	9·832493	11 25	10·167507	9·967249	11 46	10·032751	10·134756	11 21	9·865244	38	30
51	24	9·832561	12 27	10·167439	9·967376	12 51	10·032624	10·134815	12 23	9·865185	36	9
30	26	9·832629	13 30	10·167371	9·967503	13 55	10·032497	10·134874	13 25	9·865126	34	30
52	28	9·832697	14 32	10·167303	9·967629	14 59	10·032371	10·134932	14 27	9·865068	32	8
30	30	9·832765	15 34	10·167235	9·967756	15 63	10·032244	10·134991	15 29	9·865009	30	30
53	32	9·832833	16 36	10·167167	9·967883	16 68	10·032117	10·135050	16 31	9·864950	28	7
30	34	9·832901	17 39	10·167099	9·968009	17 72	10·031991	10·135108	17 33	9·864892	26	30
54	36	9·832969	18 41	10·167031	9·968136	18 76	10·031864	10·135167	18 35	9·864833	24	6
30	38	9·833037	19 43	10·166963	9·968263	19 80	10·031737	10·135226	19 37	9·864774	22	30
55	40	9·833105	20 45	10·166895	9·968389	20 84	10·031611	10·135284	20 39	9·864716	20	5
30	42	9·833173	21 48	10·166827	9·968516	21 89	10·031484	10·135343	21 41	9·864657	18	30
56	44	9·833241	22 50	10·166759	9·968643	22 93	10·031357	10·135402	22 43	9·864598	16	4
30	46	9·833309	23 52	10·166691	9·968769	23 97	10·031231	10·135461	23 45	9·864539	14	30
57	48	9·833377	24 55	10·166623	9·968896	24 101	10·031104	10·135519	24 47	9·864481	12	3
30	50	9·833444	25 57	10·166556	9·969023	25 106	10·030977	10·135578	25 49	9·864422	10	30
58	52	9·833512	26 59	10·166488	9·969149	26 110	10·030851	10·135637	26 51	9·864363	8	2
30	54	9·833580	27 61	10·166420	9·969276	27 114	10·030724	10·135696	27 53	9·864304	6	30
59	56	9·833648	28 64	10·166352	9·969403	28 118	10·030597	10·135755	28 55	9·864245	4	1
30	58	9·833716	29 66	10·166284	9·969529	29 122	10·030471	10·135814	29 57	9·864186	2	30
60	**52**	9·833783	30 68	10·166217	9·969656	30 127	10·030344	10·135873	30 59	9·864127	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

47° $3^h\ 8^m$

LOG. SINES, COSINES, &c.

$2^h\ 52^m$ 43°

″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	″
0	0	9·833783		10·166217	9·969656		10·030344	10·135873		9·864127	**8**	60
30	2	9·833851	1″ 2	10·166149	9·969783	1″ 4	10·030217	10·135931	1″ 2	9·864069	58	30
1	4	9·833919	2 4	10·166081	9·969909	2 8	10·030091	10·135990	2 4	9·864010	56	59
30	6	9·833986	3 7	10·166014	9·970036	3 13	10·029964	10·136049	3 6	9·863951	54	30
2	8	9·834054	4 9	10·165946	9·970162	4 17	10·029838	10·136108	4 8	9·863892	52	58
30	10	9·834122	5 11	10·165878	9·970289	5 21	10·029711	10·136167	5 10	9·863833	50	30
3	12	9·834189	6 13	10·165811	9·970416	6 25	10·029584	10·136226	6 12	9·863774	48	57
30	14	9·834257	7 16	10·165743	9·970542	7 30	10·029458	10·136285	7 14	9·863715	46	30
4	16	9·834325	8 18	10·165675	9·970669	8 34	10·029331	10·136344	8 16	9·863656	44	56
30	18	9·834392	9 20	10·165608	9·970796	9 38	10·029204	10·136403	9 18	9·863597	42	30
5	20	9·834460	10 22	10·165540	9·970922	10 42	10·029078	10·136462	10 20	9·863538	40	55
30	22	9·834527	11 25	10·165473	9·971049	11 46	10·028951	10·136522	11 22	9·863478	38	30
6	24	9·834595	12 27	10·165405	9·971175	12 51	10·028825	10·136581	12 24	9·863419	36	54
30	26	9·834662	13 29	10·165338	9·971302	13 55	10·028698	10·136640	13 26	9·863360	34	30
7	28	9·834730	14 31	10·165270	9·971429	14 59	10·028571	10·136699	14 28	9·863301	32	53
30	30	9·834797	15 34	10·165203	9·971555	15 63	10·028445	10·136758	15 30	9·863242	30	30
8	32	9·834865	16 36	10·165135	9·971682	16 68	10·028318	10·136817	16 32	9·863183	28	52
30	34	9·834932	17 38	10·165068	9·971808	17 72	10·028192	10·136876	17 33	9·863124	26	30
9	36	9·834999	18 41	10·165001	9·971935	18 76	10·028065	10·136936	18 35	9·863064	24	51
30	38	9·835067	19 43	10·164933	9·972062	19 80	10·027938	10·136995	19 37	9·863005	22	30
10	40	9·835134	20 45	10·164866	9·972188	20 84	10·027812	10·137054	20 39	9·862946	20	50
30	42	9·835201	21 47	10·164799	9·972315	21 89	10·027685	10·137113	21 41	9·862887	18	30
11	44	9·835269	22 49	10·164731	9·972441	22 93	10·027559	10·137173	22 43	9·862827	16	49
30	46	9·835336	23 52	10·164664	9·972568	23 97	10·027432	10·137232	23 45	9·862768	14	30
12	48	9·835403	24 54	10·164597	9·972695	24 101	10·027305	10·137291	24 47	9·862709	12	48
30	50	9·835471	25 56	10·164529	9·972821	25 105	10·027179	10·137350	25 49	9·862650	10	30
13	52	9·835538	26 58	10·164462	9·972948	26 110	10·027052	10·137410	26 51	9·862590	8	47
30	54	9·835605	27 61	10·164395	9·973074	27 114	10·026926	10·137469	27 53	9·862531	6	30
14	56	9·835672	28 63	10·164328	9·973201	28 118	10·026799	10·137529	28 55	9·862471	4	46
30	58	9·835739	29 65	10·164261	9·973327	29 122	10·026673	10·137588	29 57	9·862412	2	30
15	**53**	9·835807	30 68	10·164193	9·973454	30 126	10·026546	10·137647	30 59	9·862353	**7**	45
30	2	9·835874	1 2	10·164126	9·973581	1 4	10·026419	10·137707	1 2	9·862293	58	30
16	4	9·835941	2 4	10·164059	9·973707	2 8	10·026293	10·137766	2 4	9·862234	56	44
30	6	9·836008	3 7	10·163992	9·973834	3 13	10·026166	10·137826	3 6	9·862174	54	30
17	8	9·836075	4 9	10·163925	9·973960	4 17	10·026040	10·137885	4 8	9·862115	52	43
30	10	9·836142	5 11	10·163858	9·974087	5 21	10·025913	10·137945	5 10	9·862055	50	30
18	12	9·836209	6 13	10·163791	9·974213	6 25	10·025787	10·138004	6 12	9·861996	48	42
30	14	9·836276	7 16	10·163724	9·974340	7 30	10·025660	10·138064	7 14	9·861936	46	30
19	16	9·836343	8 18	10·163657	9·974466	8 34	10·025534	10·138123	8 16	9·861877	44	41
30	18	9·836410	9 20	10·163590	9·974593	9 38	10·025407	10·138183	9 18	9·861817	42	30
20	20	9·836477	10 22	10·163523	9·974720	10 42	10·025280	10·138242	10 20	9·861758	40	40
30	22	9·836544	11 25	10·163456	9·974846	11 46	10·025154	10·138302	11 22	9·861698	38	30
21	24	9·836611	12 27	10·163389	9·974973	12 51	10·025027	10·138362	12 24	9·861638	36	39
30	26	9·836678	13 29	10·163322	9·975099	13 55	10·024901	10·138421	13 26	9·861579	34	30
22	28	9·836745	14 31	10·163255	9·975226	14 59	10·024774	10·138481	14 28	9·861519	32	38
30	30	9·836812	15 33	10·163188	9·975352	15 63	10·024648	10·138541	15 30	9·861459	30	30
23	32	9·836878	16 36	10·163122	9·975479	16 68	10·024521	10·138600	16 32	9·861400	28	37
30	34	9·836945	17 38	10·163055	9·975605	17 72	10·024395	10·138660	17 34	9·861340	26	30
24	36	9·837012	18 40	10·162988	9·975732	18 76	10·024268	10·138720	18 36	9·861280	24	36
30	38	9·837079	19 42	10·162921	9·975858	19 80	10·024142	10·138779	19 38	9·861221	22	30
25	40	9·837146	20 45	10·162854	9·975985	20 84	10·024015	10·138839	20 40	9·861161	20	35
30	42	9·837212	21 47	10·162788	9·976111	21 89	10·023889	10·138899	21 42	9·861101	18	30
26	44	9·837279	22 49	10·162721	9·976238	22 93	10·023762	10·138959	22 44	9·861041	16	34
30	46	9·837346	23 52	10·162654	9·976364	23 97	10·023636	10·139019	23 46	9·860981	14	30
27	48	9·837412	24 54	10·162588	9·976491	24 101	10·023509	10·139078	24 48	9·860922	12	33
30	50	9·837479	25 56	10·162521	9·976617	25 105	10·023383	10·139138	25 50	9·860862	10	30
28	52	9·837546	26 58	10·162454	9·976744	26 110	10·023256	10·139198	26 52	9·860802	8	32
30	54	9·837612	27 60	10·162388	9·976870	27 114	10·023130	10·139258	27 54	9·860742	6	30
29	56	9·837679	28 63	10·162321	9·976997	28 118	10·023003	10·139318	28 56	9·860682	4	31
30	58	9·837746	29 65	10·162254	9·977123	29 122	10·022877	10·139378	29 58	9·860622	2	30
30	**54**	9·837812	30 67	10·162188	9·977250	30 126	10·022750	10·139438	30 60	9·860562	0	30
″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	″

46 $3^h\ 6^m$

LOG. SINES, COSINES, &c.

$2^h\ 54^m$ — 43°

′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
30	0	9·837812		10·162188	9·977250		10·022750	10·139438		9·860562	**6**	30
30	2	9·837879	1″ 2	10·162121	9·977377	1″ 4	10·022623	10·139498	1″ 2	9·860502	58	30
31	4	9·837945	2 4	10·162055	9·977503	2 8	10·022497	10·139558	2 4	9·860442	56	29
30	6	9·838012	3 7	10·161988	9·977630	3 13	10·022370	10·139618	3 6	9·860382	54	30
32	8	9·838078	4 9	10·161922	9·977756	4 17	10·022244	10·139678	4 8	9·860322	52	28
30	10	9·838145	5 11	10·161855	9·977882	5 21	10·022118	10·139738	5 10	9·860262	50	30
33	12	9·838211	6 13	10·161789	9·978009	6 25	10·021991	10·139798	6 12	9·860202	48	27
30	14	9·838278	7 15	10·161722	9·978135	7 30	10·021865	10·139858	7 14	9·860142	46	30
34	16	9·838344	8 17	10·161656	9·978262	8 34	10·021738	10·139918	8 16	9·860082	44	26
30	18	9·838410	9 20	10·161590	9·978388	9 38	10·021612	10·139978	9 18	9·860022	42	30
35	20	9·838477	10 22	10·161523	9·978515	10 42	10·021485	10·140038	10 20	9·859962	40	25
30	22	9·838543	11 24	10·161457	9·978641	11 46	10·021359	10·140098	11 22	9·859902	38	30
36	24	9·838610	12 27	10·161390	9·978768	12 51	10·021232	10·140158	12 24	9·859842	36	24
30	26	9·838676	13 29	10·161324	9·978894	13 55	10·021106	10·140219	13 26	9·859781	34	30
37	28	9·838742	14 31	10·161258	9·979021	14 59	10·020979	10·140279	14 28	9·859721	32	23
30	30	9·838808	15 33	10·161192	9·979147	15 63	10·020853	10·140339	15 30	9·859661	30	30
38	32	9·838875	16 35	10·161125	9·979274	16 67	10·020726	10·140399	16 32	9·859601	28	22
30	34	9·838941	17 37	10·161059	9·979400	17 72	10·020600	10·140459	17 34	9·859541	26	30
39	36	9·839007	18 40	10·160993	9·979527	18 76	10·020473	10·140520	18 36	9·859480	24	21
30	38	9·839073	19 42	10·160927	9·979653	19 80	10·020347	10·140580	19 38	9·859420	22	30
40	40	9·839140	20 44	10·160860	9·979780	20 84	10·020220	10·140640	20 40	9·859360	20	20
30	42	9·839206	21 46	10·160794	9·979906	21 89	10·020094	10·140700	21 42	9·859300	18	30
41	44	9·839272	22 48	10·160728	9·980033	22 93	10·019967	10·140761	22 44	9·859239	16	19
30	46	9·839338	23 51	10·160662	9·980159	23 97	10·019841	10·140821	23 46	9·859179	14	30
42	48	9·839404	24 53	10·160596	9·980286	24 101	10·019714	10·140881	24 48	9·859119	12	18
30	50	9·839470	25 55	10·160530	9·980412	25 105	10·019588	10·140942	25 50	9·859058	10	30
43	52	9·839536	26 57	10·160464	9·980538	26 110	10·019462	10·141002	26 52	9·858998	8	17
30	54	9·839602	27 60	10·160398	9·980665	27 114	10·019335	10·141063	27 54	9·858937	6	30
44	56	9·839668	28 62	10·160332	9·980791	28 118	10·019209	10·141123	28 56	9·858877	4	16
30	58	9·839734	29 64	10·160266	9·980918	29 122	10·019082	10·141183	29 58	9·858817	2	30
45	**55**	9·839800	30 66	10·160200	9·981044	30 126	10·018956	10·141244	30 60	9·858756	**5**	15
30	2	9·839866	1 2	10·160134	9·981171	1 4	10·018829	10·141304	1 2	9·858696	58	30
46	4	9·839932	2 4	10·160068	9·981297	2 8	10·018703	10·141365	2 4	9·858635	56	14
30	6	9·839998	3 7	10·160002	9·981424	3 13	10·018576	10·141425	3 6	9·858575	54	30
47	8	9·840064	4 9	10·159936	9·981550	4 17	10·018450	10·141486	4 8	9·858514	52	13
30	10	9·840130	5 11	10·159870	9·981677	5 21	10·018323	10·141546	5 10	9·858454	50	30
48	12	9·840196	6 13	10·159804	9·981803	6 25	10·018197	10·141607	6 12	9·858393	48	12
30	14	9·840262	7 15	10·159738	9·981929	7 29	10·018071	10·141668	7 14	9·858332	46	30
49	16	9·840328	8 17	10·159672	9·982056	8 34	10·017944	10·141728	8 16	9·858272	44	11
30	18	9·840393	9 20	10·159607	9·982182	9 38	10·017818	10·141789	9 18	9·858211	42	30
50	20	9·840459	10 22	10·159541	9·982309	10 42	10·017691	10·141849	10 20	9·858151	40	10
30	22	9·840525	11 24	10·159475	9·982435	11 46	10·017565	10·141910	11 22	9·858090	38	30
51	24	9·840591	12 26	10·159409	9·982562	12 51	10·017438	10·141971	12 24	9·858029	36	9
30	26	9·840657	13 29	10·159343	9·982688	13 55	10·017312	10·142032	13 26	9·857968	34	30
52	28	9·840722	14 31	10·159278	9·982814	14 59	10·017186	10·142092	14 28	9·857908	32	8
30	30	9·840788	15 33	10·159212	9·982941	15 63	10·017059	10·142153	15 30	9·857847	30	30
53	32	9·840854	16 35	10·159146	9·983067	16 67	10·016933	10·142214	16 32	9·857786	28	7
30	34	9·840919	17 37	10·159081	9·983194	17 72	10·016806	10·142274	17 34	9·857726	26	30
54	36	9·840985	18 39	10·159015	9·983320	18 76	10·016680	10·142335	18 36	9·857665	24	6
30	38	9·841051	19 42	10·158949	9·983447	19 80	10·016553	10·142396	19 38	9·857604	22	30
55	40	9·841116	20 44	10·158884	9·983573	20 84	10·016427	10·142457	20 40	9·857543	20	5
30	42	9·841182	21 46	10·158818	9·983699	21 88	10·016301	10·142518	21 42	9·857482	18	30
56	44	9·841247	22 48	10·158753	9·983826	22 93	10·016174	10·142578	22 45	9·857422	16	4
30	46	9·841313	23 51	10·158687	9·983952	23 97	10·016048	10·142639	23 46	9·857361	14	30
57	48	9·841378	24 53	10·158622	9·984079	24 101	10·015921	10·142700	24 48	9·857300	12	3
30	50	9·841444	25 55	10·158556	9·984205	25 105	10·015795	10·142761	25 51	9·857239	10	30
58	52	9·841509	26 57	10·158491	9·984331	26 109	10·015668	10·142822	26 53	9·857178	8	2
30	54	9·841575	27 59	10·158425	9·984458	27 114	10·015542	10·142883	27 55	9·857117	6	30
59	56	9·841640	28 61	10·158360	9·984584	28 118	10·015416	10·142944	28 57	9·857056	4	1
30	58	9·841706	29 64	10·158294	9·984711	29 122	10·015289	10·143005	29 59	9·856995	2	30
60	**56**	9·841771	30 66	10·158229	9·984837	30 126	10·015163	10·143066	30 61	9·856934	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m. s.	′ ″

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′ ″	m. s.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m. s.	′ ″
0	0	9·841771		10·158229	9·984837		10·015163	10·143066		9·856934	4	60
30	2	9·841837	1″ 2	10·158163	9·984964	1″ 4	10·015036	10·143127	1″ 2	9·856873	58	30
1	4	9·841902	2 4	10·158098	9·985090	2 8	10·014910	10·143188	2 4	9·856812	56	59
30	6	9·841967	3 7	10·158033	9·985216	3 13	10·014784	10·143249	3 6	9·856751	54	30
2	8	9·842033	4 9	10·157967	9·985343	4 17	10·014657	10·143310	4 8	9·856690	52	58
30	10	9·842098	5 11	10·157902	9·985469	5 21	10·014531	10·143371	5 10	9·856629	50	30
3	12	9·842163	6 13	10·157837	9·985596	6 25	10·014404	10·143432	6 12	9·856568	48	57
30	14	9·842229	7 15	10·157771	9·985722	7 29	10·014278	10·143493	7 14	9·856507	46	30
4	16	9·842294	8 17	10·157706	9·985848	8 34	10·014152	10·143554	8 16	9·856446	44	56
30	18	9·842359	9 20	10·157641	9·985975	9 38	10·014025	10·143616	9 18	9·856384	42	30
5	20	9·842424	10 22	10·157576	9·986101	10 42	10·013899	10·143677	10 20	9·856323	40	55
30	22	9·842490	11 24	10·157510	9·986228	11 46	10·013772	10·143738	11 22	9·856262	38	30
6	24	9·842555	12 26	10·157445	9·986354	12 51	10·013646	10·143799	12 24	9·856201	36	54
30	26	9·842620	13 28	10·157380	9·986480	13 55	10·013520	10·143860	13 27	9·856140	34	30
7	28	9·842685	14 30	10·157315	9·986607	14 59	10·013393	10·143922	14 29	9·856078	32	53
30	30	9·842750	15 33	10·157250	9·986733	15 63	10·013267	10·143983	15 31	9·856017	30	30
8	32	9·842815	16 35	10·157185	9·986860	16 67	10·013140	10·144044	16 33	9·855956	28	52
30	34	9·842880	17 37	10·157120	9·986986	17 72	10·013014	10·144106	17 35	9·855895	26	30
9	36	9·842946	18 39	10·157054	9·987112	18 76	10·012888	10·144167	18 37	9·855833	24	51
30	38	9·843011	19 41	10·156989	9·987239	19 80	10·012761	10·144228	19 39	9·855772	22	30
10	40	9·843076	20 43	10·156924	9·987365	20 84	10·012635	10·144289	20 41	9·855711	20	50
30	42	9·843141	21 46	10·156859	9·987491	21 88	10·012509	10·144351	21 43	9·855649	18	30
11	44	9·843206	22 48	10·156794	9·987618	22 93	10·012382	10·144412	22 45	9·855588	16	49
30	46	9·843271	23 50	10·156729	9·987744	23 97	10·012256	10·144474	23 47	9·855526	14	30
12	48	9·843336	24 52	10·156664	9·987871	24 101	10·012129	10·144535	24 49	9·855465	12	48
30	50	9·843401	25 54	10·156599	9·987997	25 105	10·012003	10·144596	25 51	9·855404	10	30
13	52	9·843466	26 56	10·156534	9·988123	26 109	10·011877	10·144658	26 53	9·855342	8	47
30	54	9·843530	27 59	10·156470	9·988250	27 114	10·011750	10·144719	27 55	9·855281	6	30
14	56	9·843595	28 61	10·156405	9·988376	28 118	10·011624	10·144781	28 57	9·855219	4	46
30	58	9·843660	29 63	10·156340	9·988503	29 122	10·011497	10·144842	29 59	9·855158	2	30
15	**57**	9·843725	30 65	10·156275	9·988629	30 126	10·011371	10·144904	30 61	9·855096	**3**	45
30	2	9·843790	1 2	10·156210	9·988755	1 4	10·011245	10·144965	1 2	9·855035	58	30
16	4	9·843855	2 4	10·156145	9·988882	2 8	10·011118	10·145027	2 4	9·854973	56	44
30	6	9·843919	3 6	10·156081	9·989008	3 13	10·010992	10·145089	3 6	9·854911	54	30
17	8	9·843984	4 9	10·156016	9·989134	4 17	10·010866	10·145150	4 8	9·854850	52	43
30	10	9·844049	5 11	10·155951	9·989261	5 21	10·010739	10·145212	5 10	9·854788	50	30
18	12	9·844114	6 13	10·155886	9·989387	6 25	10·010613	10·145273	6 12	9·854727	48	42
30	14	9·844178	7 15	10·155822	9·989513	7 29	10·010487	10·145335	7 14	9·854665	46	30
19	16	9·844243	8 17	10·155757	9·989640	8 34	10·010360	10·145397	8 16	9·854603	44	41
30	18	9·844308	9 19	10·155692	9·989766	9 38	10·010234	10·145458	9 19	9·854542	42	30
20	20	9·844372	10 21	10·155628	9·989893	10 42	10·010107	10·145520	10 21	9·854480	40	40
30	22	9·844437	11 24	10·155563	9·990019	11 46	10·009981	10·145582	11 23	9·854418	38	30
21	24	9·844502	12 26	10·155498	9·990145	12 51	10·009855	10·145644	12 25	9·854356	36	39
30	26	9·844566	13 28	10·155434	9·990272	13 55	10·009728	10·145705	13 27	9·854295	34	30
22	28	9·844631	14 30	10·155369	9·990398	14 59	10·009602	10·145767	14 29	9·854233	32	38
30	30	9·844696	15 32	10·155304	9·990524	15 63	10·009476	10·145829	15 31	9·854171	30	30
23	32	9·844760	16 34	10·155240	9·990651	16 67	10·009349	10·145891	16 33	9·854109	28	37
30	34	9·844825	17 37	10·155175	9·990777	17 72	10·009223	10·145953	17 35	9·854047	26	30
24	36	9·844889	18 39	10·155111	9·990903	18 76	10·009097	10·146014	18 37	9·853986	24	36
30	38	9·844954	19 41	10·155046	9·991030	19 80	10·008970	10·146076	19 39	9·853924	22	30
25	40	9·845018	20 43	10·154982	9·991156	20 84	10·008844	10·146138	20 41	9·853862	20	35
30	42	9·845083	21 45	10·154917	9·991283	21 88	10·008717	10·146200	21 43	9·853800	18	30
26	44	9·845147	22 47	10·154853	9·991409	22 93	10·008591	10·146262	22 45	9·853738	16	34
30	46	9·845211	23 49	10·154789	9·991535	23 97	10·008465	10·146324	23 47	9·853676	14	30
27	48	9·845276	24 52	10·154724	9·991662	24 101	10·008338	10·146386	24 49	9·853614	12	33
30	50	9·845340	25 54	10·154660	9·991788	25 105	10·008212	10·146448	25 51	9·853552	10	30
28	52	9·845405	26 56	10·154595	9·991914	26 109	10·008086	10·146510	26 54	9·853490	8	32
30	54	9·845469	27 58	10·154531	9·992041	27 114	10·007959	10·146572	27 56	9·853428	6	30
29	56	9·845533	28 60	10·154467	9·992167	28 118	10·007833	10·146634	28 58	9·853366	4	31
30	58	9·845598	29 62	10·154402	9·992293	29 122	10·007707	10·146696	29 60	9·853304	2	30
30	**58**	9·845662	30 64	10·154338	9·992420	30 126	10·007580	10·146758	30 62	9·853242	0	30
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

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′ ″	m.	Sine	Parts	Cosec.	Tangent	Parts	Cotang.	Secant	Parts	Cosine	m.	′ ″
30	0	9·845662		10·154338	9·992420		10·007580	10·146758		9·853242	**2**	30
30	2	9·845726	1″ 2	10·154274	9·992546	1″ 4	10·007454	10·146820	1″ 2	9·853180	58	30
31	4	9·845790	2 4	10·154210	9·992672	2 8	10·007328	10·146882	2 4	9·853118	56	29
30	6	9·845855	3 6	10·154145	9·992799	3 13	10·007201	10·146944	3 6	9·853056	54	30
32	8	9·845919	4 8	10·154081	9·992925	4 17	10·007075	10·147006	4 8	9·852994	52	28
30	10	9·845983	5 10	10·154017	9·993051	5 21	10·006949	10·147069	5 10	9·852931	50	30
33	12	9·846047	6 13	10·153953	9·993178	6 25	10·006822	10·147131	6 12	9·852869	48	27
30	14	9·846111	7 15	10·153889	9·993304	7 29	10·006696	10·147193	7 15	9·852807	46	30
34	16	9·846175	8 17	10·153825	9·993430	8 34	10·006570	10·147255	8 17	9·852745	44	26
30	18	9·846240	9 19	10·153760	9·993557	9 38	10·006443	10·147317	9 19	9·852683	42	30
35	20	9·846304	10 21	10·153696	9·993683	10 42	10·006317	10·147380	10 21	9·852620	40	25
30	22	9·846368	11 23	10·153632	9·993810	11 46	10·006190	10·147442	11 23	9·852558	38	30
36	24	9·846432	12 26	10·153568	9·993936	12 51	10·006064	10·147504	12 25	9·852496	36	24
30	26	9·846496	13 28	10·153504	9·994062	13 55	10·005938	10·147566	13 27	9·852434	34	30
37	28	9·846560	14 30	10·153440	9·994189	14 59	10·005811	10·147629	14 29	9·852371	32	23
30	30	9·846624	15 32	10·153376	9·994315	15 63	10·005685	10·147691	15 31	9·852309	30	30
38	32	9·846688	16 34	10·153312	9·994441	16 67	10·005559	10·147753	16 33	9·852247	28	22
30	34	9·846752	17 36	10·153248	9·994568	17 72	10·005432	10·147816	17 35	9·852184	26	30
39	36	9·846816	18 38	10·153184	9·994694	18 76	10·005306	10·147878	18 37	9·852122	24	21
30	38	9·846880	19 40	10·153120	9·994820	19 80	10·005180	10·147941	19 40	9·852059	22	30
40	40	9·846944	20 42	10·153056	9·994947	20 84	10·005053	10·148003	20 42	9·851997	20	20
30	42	9·847008	21 45	10·152992	9·995073	21 88	10·004927	10·148066	21 44	9·851934	18	30
41	44	9·847071	22 47	10·152929	9·995199	22 93	10·004801	10·148128	22 46	9·851872	16	19
30	46	9·847135	23 49	10·152865	9·995326	23 97	10·004674	10·148190	23 48	9·851810	14	30
42	48	9·847199	24 51	10·152801	9·995452	24 101	10·004548	10·148253	24 50	9·851747	12	18
30	50	9·847263	25 53	10·152737	9·995578	25 105	10·004422	10·148315	25 52	9·851685	10	30
43	52	9·847327	26 55	10·152673	9·995705	26 109	10·004295	10·148378	26 54	9·851622	8	17
30	54	9·847391	27 58	10·152609	9·995831	27 114	10·004169	10·148441	27 56	9·851559	6	30
44	56	9·847454	28 60	10·152546	9·995957	28 118	10·004043	10·148503	28 58	9·851497	4	16
30	58	9·847518	29 62	10·152482	9·996084	29 122	10·003916	10·148566	29 60	9·851434	2	30
45	**59**	9·847582	30 64	10·152418	9·996210	30 126	10·003790	10·148628	30 62	9·851372	**1**	15
30	2	9·847646	1 2	10·152354	9·996336	1 4	10·003664	10·148691	1 2	9·851309	58	30
46	4	9·847709	2 4	10·152291	9·996463	2 8	10·003537	10·148754	2 4	9·851246	56	14
30	6	9·847773	3 6	10·152227	9·996589	3 13	10·003411	10·148816	3 6	9·851184	54	30
47	8	9·847836	4 8	10·152164	9·996715	4 17	10·003285	10·148879	4 8	9·851121	52	13
30	10	9·847900	5 11	10·152100	9·996842	5 21	10·003158	10·148942	5 10	9·851058	50	30
48	12	9·847964	6 13	10·152036	9·996968	6 25	10·003032	10·149004	6 13	9·850996	48	12
30	14	9·848027	7 15	10·151973	9·997094	7 29	10·002906	10·149067	7 15	9·850933	46	30
49	16	9·848091	8 17	10·151909	9·997221	8 34	10·002779	10·149130	8 17	9·850870	44	11
30	18	9·848155	9 19	10·151845	9·997347	9 38	10·002653	10·149193	9 19	9·850807	42	30
50	20	9·848218	10 21	10·151782	9·997473	10 42	10·002527	10·149255	10 21	9·850745	40	10
30	22	9·848282	11 23	10·151718	9·997600	11 46	10·002400	10·149318	11 23	9·850682	38	30
51	24	9·848345	12 25	10·151655	9·997726	12 51	10·002274	10·149381	12 25	9·850619	36	9
30	26	9·848409	13 28	10·151591	9·997852	13 55	10·002148	10·149444	13 27	9·850556	34	30
52	28	9·848472	14 30	10·151528	9·997979	14 59	10·002021	10·149507	14 29	9·850493	32	8
30	30	9·848535	15 32	10·151465	9·998105	15 63	10·001895	10·149570	15 31	9·850430	30	30
53	32	9·848599	16 34	10·151401	9·998231	16 67	10·001769	10·149632	16 34	9·850368	28	7
30	34	9·848662	17 36	10·151338	9·998358	17 72	10·001642	10·149695	17 36	9·850305	26	30
54	36	9·848726	18 38	10·151274	9·998484	18 76	10·001516	10·149758	18 38	9·850242	24	6
30	38	9·848789	19 40	10·151211	9·998610	19 80	10·001390	10·149821	19 40	9·850179	22	30
55	40	9·848852	20 43	10·151148	9·998737	20 84	10·001263	10·149884	20 42	9·850116	20	5
30	42	9·848916	21 45	10·151084	9·998863	21 88	10·001137	10·149947	21 44	9·850053	18	30
56	44	9·848979	22 47	10·151021	9·998989	22 93	10·001011	10·150010	22 46	9·849990	16	4
30	46	9·849042	23 49	10·150958	9·999116	23 97	10·000884	10·150073	23 48	9·849927	14	30
57	48	9·849106	24 51	10·150894	9·999242	24 101	10·000758	10·150136	24 50	9·849864	12	3
30	50	9·849169	25 53	10·150831	9·999368	25 105	10·000632	10·150199	25 52	9·849801	10	30
58	52	9·849232	26 55	10·150768	9·999495	26 109	10·000505	10·150262	26 54	9·849738	8	2
30	54	9·849295	27 57	10·150705	9·999621	27 114	10·000379	10·150326	27 56	9·849674	6	30
59	56	9·849359	28 60	10·150641	9·999747	28 118	10·000253	10·150389	28 59	9·849611	4	1
30	58	9·849422	29 62	10·150578	9·999874	29 122	10·000126	10·150452	29 61	9·849548	2	30
60	**60**	9·849485	30 64	10·150515	10·000000	30 126	10·000000	10·150515	30 63	9·849485	0	0
′ ″	m.	Cosine	Parts	Secant	Cotang.	Parts	Tangent	Cosec.	Parts	Sine	m.	′ ″

45° $3^h\ 0^m$

LOG. OF THE SQUARE OF THE SINE*
OF HALF THE ARC.

	0°				1°				2°			
	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	
	0h 0m	0h 1m	0h 2m	0h 3m	0h 4m	0h 5m	0h 6m	0h 7m	0h 8m	0h 9m	0h 10m	s.
			5·	5·		6·	6	6·	6·	6·	6·	
0′ 0″		4·67757	27963	63181	5·88168	07550	23385	36774	48371	58600	67751	0
15	1·12127	4·69193	28684	63662	5·88530	07839	23626	36980	48552	58761	67895	1
30	1·72333	4·70605	29399	64141	5·88889	08127	23866	37186	48732	58921	68040	2
45	2·07552	4·71995	30108	64617	5·89247	08414	24106	37392	48912	59081	68184	3
1 0	2·32539	4·73363	30811	65090	5·89604	08700	24345	37597	49092	59241	68328	4
15	2·51921	4·74710	31509	65561	5·89959	08985	24583	37802	49271	59401	68471	5
30	2·67757	4·76036	32201	66029	5·90313	09270	24821	38006	49450	59560	68615	6
45	2·81147	4 77342	32888	66495	5·90665	09553	25058	38209	49628	59719	68758	7
2 0	2·92745	4·78629	33569	66958	5·91016	09836	25294	38412	49807	59878	68901	8
15	3·02976	4·79897	34245	67419	5·91366	10117	25530	38615	49984	60036	69044	9
30	3·12127	4·81147	34916	67877	5·91714	10398	25765	38817	50162	60194	69186	10
45	3·20406	4·82379	35581	68333	5·92061	10677	25999	39019	50339	60352	69328	11
3 0	3·27963	4·83594	36242	68787	5·92406	10956	26233	39220	50516	60509	69470	12
15	3·34916	4·84792	36897	69238	5·92750	11234	26466	39421	50692	60666	69612	13
30	3·41353	4·85973	37548	69687	5·93093	11511	26699	39622	50868	60823	69754	14
45	3 47345	4·87139	38194	70133	5·93434	11787	26931	39821	51044	60980	69895	15
4 0	3·52951	4·88290	38835	70578	5·93774	12063	27162	40021	51219	61136	70036	16
15	3·58217	4·89425	39471	71020	5·94113	12337	27393	40220	51394	61292	70177	17
30	3·63182	4·90546	40103	71460	5·94450	12611	27623	40418	51568	61448	70318	18
45	3·67878	4·91653	40730	71897	5·94786	12883	27852	40616	51743	61604	70458	19
5 0	3·72333	4·92745	41352	72332	5·95121	13155	28081	40814	51916	61759	70598	20
15	3·76571	4·93824	41971	72766	5·95454	13426	28309	41011	52090	61914	70738	21
30	3·80612	4·94890	42584	73197	5 95786	13696	28537	41208	52263	62068	70878	22
45	3·84473	4·95943	43194	73626	5·96117	13966	28764	41404	52436	62223	71017	23
6 0	3·88169	4·96983	43799	74052	5·96447	14234	28991	41600	52608	62377	71157	24
15	3·91715	4·98011	44400	74477	5·96775	14502	29217	41795	52780	62531	71296	25
30	3·95122	4·99027	44997	74900	5·97102	14769	29442	41990	52952	62684	71435	26
45	3·98400	5·00031	45590	75320	5·97428	15035	29667	42185	53124	62838	71573	27
7 0	4 01559	5·01024	46179	75739	5·97753	15300	29891	42379	53295	62991	71712	28
15	4·04607	5·02005	46764	76156	5·98076	15564	30114	42573	53466	63143	71850	29
30	4 07551	5·02976	47345	76570	5·98399	15828	30337	42766	53636	63296	71988	30
45	4·10400	5·03935	47922	76983	5·98720	16091	30560	42959	53806	63448	72125	31
8 0	4·13157	5·04885	48495	77394	5·99040	16353	30781	43151	53976	63600	72263	32
15	4·15830	5·05824	49065	77802	5·99358	16614	31003	43343	54146	63752	72400	33
30	4·18423	5·06753	49631	78209	5·99676	16874	31223	43534	54315	63903	72537	34
45	4·20941	5·07672	50193	78614	5·99992	17134	31444	43726	54484	64054	72674	35
9 0	4·23383	5·08581	50752	79017	6·00308	17393	31663	43916	54652	64205	72811	36
15	4·25768	5·09481	51307	79418	6·00622	17651	31882	44106	54820	64356	72947	37
30	4·28084	5·10372	51858	79818	6·00935	17908	32101	44296	54988	64506	73084	38
45	4·30340	5·11254	52406	80215	6·01247	18165	32319	44486	55156	64656	73220	39
10 0	4 32539	5·12127	52951	80611	6·01557	18421	32536	44675	55323	64806	73355	40
15	4 34684	5·12991	53492	81005	6·01867	18676	32753	44863	55490	64956	73491	41
30	4·36777	5·13847	54030	81397	6·02176	18930	32969	45052	55656	65105	73626	42
45	4·38821	5·14694	54564	81787	6·02483	19184	33185	45239	55822	65254	73761	43
11 0	4·40818	5·15534	55095	82176	6·02789	19437	33400	45427	55988	65403	73896	44
15	4·42770	5·16365	55623	82563	6·03095	19689	33615	45614	56154	65552	74031	45
30	4·44679	5·17188	56148	82948	6·03399	19940	33829	45800	56319	65700	74166	46
45	4·46547	5·18004	56670	83331	6·03702	20191	34043	45986	56484	65848	74300	47
12 0	4·48375	5·18812	57189	83713	6·04004	20441	34256	46172	56649	65996	74434	48
15	4·50166	5·19612	57704	84093	6·04305	20690	34469	46358	56813	66144	74568	49
30	4·51921	5·20406	58216	84472	6·04605	20938	34681	46543	56977	66291	74702	50
45	4·53641	5·21192	58726	84849	6·04904	21186	34892	46727	57141	66438	74835	51
13 0	4·55328	5·21971	59232	85224	6·05202	21433	35103	46911	57304	66585	74969	52
15	4·56982	5·22743	59736	85597	6·05499	21680	35314	47095	57467	66731	75102	53
30	4·58606	5·23508	60236	85969	6·05795	21925	35524	47279	57630	66878	75235	54
45	4·60200	5·24267	60734	86340	6·06090	22170	35734	47462	57792	67024	75367	55
14 0	4·61765	5·25019	61229	86709	6·06384	22415	35943	47644	57955	67170	75500	56
15	4·63302	5·25764	61721	87076	6·06677	22658	36151	47826	58117	67315	75632	57
30	4·64813	5·26503	62211	87442	6·06969	22901	36359	48008	58278	67461	75764	58
45	4·66298	5·27236	62697	87806	6·07260	23144	36567	48190	58439	67606	75896	59

* Same as log. haversine of Inman's Tables.

LOG. SINE SQUARE

	2° 45′	3° 0	3° 15′	3° 30′	3° 45′	4° 0′	4° 15′	4° 30′	4° 45′	5° 0′	5° 15′	
	0h 11m	0h 12m	0h 13m	0h 14m	0h 15m	0h 16m	0h 17m	0h 18m	0h 19m	0h 20m	0h 21m	s.
	6·	6·	6·		7·	7·	7·	7·	7·	7·	7·	
0′ 0″	76028	83584	90535	6·96970	02960	08564	13827	18790	23483	27936	32171	0
15	76159	83704	90646	6·97073	03057	08654	13912	18870	23559	28008	32240	1
30	76290	83825	90757	6·97176	03153	08745	13997	18950	23635	28080	32309	2
45	76421	83945	90868	6·97279	03249	08835	14082	19030	23711	28153	32377	3
1 0	76552	84065	90979	6·97382	03345	08925	14167	19111	23787	28225	32446	4
15	76683	84185	91089	6·97485	03441	09015	14252	19191	23863	28297	32515	5
30	76814	84304	91200	6·97588	03537	09105	14337	19271	23939	28369	32583	6
45	76944	84424	91310	6·97690	03633	09195	14421	19350	24015	28441	32652	7
2 0	77074	84543	91421	6·97793	03729	09284	14506	19430	24090	28513	32720	8
15	77204	84663	91531	6·97895	03824	09374	14590	19510	24166	28584	32789	9
30	77334	84782	91641	6·97997	03920	09464	14674	19590	24241	28656	32857	10
45	77463	84900	91751	6·98099	04015	09553	14759	19669	24317	28728	32925	11
3 0	77592	85019	91860	6·98201	04110	09642	14843	19749	24392	28800	32994	12
15	77722	85138	91970	6·98303	04205	09732	14927	19828	24468	28871	33062	13
30	77851	85256	92079	6·98405	04300	09821	15011	19908	24543	28943	33130	14
45	77979	85374	92189	6·98506	04395	09910	15095	19987	24618	29014	33198	15
4 0	78108	85492	92298	6·98608	04490	09999	15179	20066	24693	29086	33266	16
15	78236	85610	92407	6·98709	04585	10088	15262	20145	24768	29157	33334	17
30	78364	85728	92516	6·98811	04680	10177	15346	20225	24843	29228	33402	18
45	78492	85846	92624	6·98912	04774	10265	15430	20304	24918	29299	33470	19
5 0	78620	85963	92733	6·99013	04869	10354	15513	20383	24993	29371	33538	20
15	78748	86080	92841	6·99114	04963	10443	15597	20461	25068	29442	33606	21
30	78875	86197	92950	6·99214	05057	10531	15680	20540	25143	29513	33673	22
45	79002	86314	93058	6·99315	05151	10619	15763	20619	25217	29584	33741	23
6 0	79129	86431	93166	6·99416	05245	10708	15846	20698	25292	29655	33809	24
15	79256	86548	93274	6·99516	05339	10796	15930	20776	25366	29726	33876	25
30	79383	86664	93382	6·99616	05433	10884	16013	20855	25441	29797	33944	26
45	79509	86781	93489	6·99717	05527	10972	16096	20933	25515	29867	34011	27
7 0	79636	86897	93597	6·99817	05620	11060	16178	21012	25590	29938	34079	28
15	79762	87013	93704	6·99917	05714	11148	16261	21090	25664	30009	34146	29
30	79888	87129	93812	7·00017	05807	11235	16344	21168	25738	30079	34213	30
45	80014	87244	93919	7·00116	05901	11323	16427	21246	25812	30150	34281	31
8 0	80139	87360	94026	7·00216	05994	11411	16509	21325	25886	30220	34348	32
15	80265	87475	94133	7·00315	06087	11498	16592	21403	25960	30291	34415	33
30	80390	87591	94239	7·00415	06180	11586	16674	21481	26034	30361	34482	34
45	80515	87706	94346	7·00514	06273	11673	16756	21558	26108	30431	34549	35
9 0	80640	87821	94453	7·00613	06366	11760	16839	21636	26182	30501	34616	36
15	80764	87935	94559	7·00712	06458	11847	16921	21714	26256	30572	34683	37
30	80889	88050	94665	7·00811	06551	11934	17003	21792	26330	30642	34750	38
45	81013	88165	94771	7·00910	06643	12021	17085	21869	26403	30712	34817	39
10 0	81137	88279	94877	7·01009	06736	12108	17167	21947	26477	30782	34884	40
15	81261	88393	94983	7·01107	06828	12195	17249	22024	26550	30852	34950	41
30	81385	88507	95089	7·01206	06920	12282	17331	22102	26624	30922	35017	42
45	81509	88621	95194	7·01304	07013	12368	17412	22179	26697	30992	35084	43
11 0	81632	88735	95300	7·01403	07105	12455	17494	22256	26771	31062	35150	44
15	81756	88848	95405	7·01501	07196	12541	17575	22333	26844	31131	35217	45
30	81879	88962	95510	7·01599	07288	12627	17657	22411	26917	31201	35283	46
45	82002	89075	95615	7·01697	07380	12714	17738	22488	26990	31271	35350	47
12 0	82124	89188	95720	7·01795	07472	12800	17820	22565	27063	31340	35416	48
15	82247	89301	95825	7·01892	07563	12886	17901	22642	27137	31410	35482	49
30	82369	89414	95930	7·01990	07655	12972	17982	22719	27210	31479	35549	50
45	82492	89527	96034	7·02088	07746	13058	18063	22795	27282	31549	35615	51
13 0	82613	89639	96139	7·02185	07837	13144	18144	22872	27355	31618	35681	52
15	82735	89752	96243	7·02282	07928	13229	18225	22949	27428	31687	35747	53
30	82857	89864	96347	7·02379	08019	13315	18306	23025	27501	31757	35813	54
45	82979	89976	96451	7·02476	08110	13401	18387	23102	27573	31826	35879	55
14 0	83100	90088	96555	7·02573	08201	13486	18468	23178	27646	31895	35945	56
15	83221	90200	96659	7·02670	08292	13572	18548	23255	27719	31964	36011	57
30	83342	90312	96763	7·02767	08383	13657	18629	23331	27791	32033	36077	58
45	83463	90423	96865	7·02864	08473	13742	18709	23407	27864	32102	36143	59

LOG. SINE SQUARE

	5°		6°				7°				8°	
	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	
′ ″	0h 22m	0h 23m	0h 24m	0h 25m	0h 26m	0h 27m	0h 28m	0h 29m	0h 30m	0h 31m	0h 32m	s.
	7.	7.	7.	7.	7.	7.	7.	7.	7.	7.	7.	
0 0	36209	40067	43760	47302	50706	53980	57135	60179	63120	65964	68717	0
15	36274	40129	43820	47360	50761	54034	57187	60229	63168	66011	68762	1
30	36340	40192	43880	47418	50817	54087	57238	60279	63216	66057	68807	2
45	36406	40255	43941	47476	50872	54141	57290	60329	63264	66103	68852	3
1 0	36471	40318	44001	47533	50928	54194	57341	60378	63312	66150	68897	4
15	36537	40380	44061	47591	50983	54247	57393	60428	63360	66196	68942	5
30	36602	40443	44121	47649	51039	54301	57444	60478	63408	66243	68987	6
45	36668	40506	44181	47707	51094	54354	57496	60527	63456	66289	69032	7
2 0	36733	40568	44241	47764	51149	54407	57547	60577	63504	66336	69077	8
15	36798	40631	44301	47821	51205	54461	57598	60627	63552	66382	69122	9
30	36864	40693	44361	47879	51260	54514	57650	60676	63600	66429	69167	10
45	36929	40756	44420	47936	51315	54567	57701	60726	63648	66475	69212	11
3 0	36994	40818	44480	47994	51370	54620	57752	60775	63696	66521	69257	12
15	37059	40880	44540	48051	51426	54673	57804	60825	63744	66568	69302	13
30	37124	40943	44600	48109	51481	54727	57855	60874	63792	66614	69347	14
45	37189	41005	44659	48166	51536	54780	57906	60924	63839	66660	69392	15
4 0	37254	41067	44719	48223	51591	54833	57957	60973	63887	66706	69437	16
15	37319	41129	44779	48280	51646	54886	58008	61022	63935	66753	69481	17
30	37384	41191	44838	48337	51701	54939	58060	61072	63983	66799	69526	18
45	37449	41253	44898	48395	51756	54992	58111	61121	64030	66845	69571	19
5 0	37514	41315	44957	48452	51811	55045	58162	61170	64078	66891	69616	20
15	37579	41377	45016	48509	51866	55097	58213	61220	64126	66937	69660	21
30	37643	41439	45076	48566	51921	55150	58264	61269	64173	66983	69705	22
45	37708	41501	45135	48623	51975	55203	58315	61318	64221	67029	69750	23
6 0	37772	41563	45194	48680	52030	55256	58366	61367	64269	67075	69794	24
15	37837	41625	45254	48737	52085	55308	58416	61417	64316	67121	69839	25
30	37902	41686	45313	48794	52140	55361	58467	61466	64364	67167	69883	26
45	37966	41748	45372	48850	52194	55414	58518	61515	64411	67213	69928	27
7 0	38030	41810	45431	48907	52249	55467	58569	61564	64458	67259	69972	28
15	38095	41871	45490	48964	52304	55519	58620	61613	64506	67305	70017	29
30	38159	41933	45549	49021	52358	55572	58670	51662	64553	67351	70061	30
45	38223	41994	45608	49077	52413	55624	58721	61711	64601	67397	70106	31
8 0	38288	42056	45667	49134	52467	55677	58772	61760	64648	67443	70150	32
15	38352	42117	45726	49191	52522	55729	58823	61809	64695	67489	70195	33
30	38416	42179	45785	49247	52576	55782	58873	61858	64743	67535	70239	34
45	38480	42240	45844	49304	52631	55834	58924	61907	64790	67580	70283	35
9 0	38544	42301	45903	49360	52685	55887	58974	61955	64837	67626	70328	36
15	38608	42363	45962	49417	52739	55939	59025	62004	64885	67672	70372	37
30	38672	42424	46020	49473	52794	55992	59075	62053	64932	67717	70416	38
45	38736	42485	46079	49530	52848	56044	59126	62102	64979	67763	70461	39
10 0	38800	42546	46138	49586	52902	56096	59176	62151	65026	67809	70505	40
15	38863	42607	46196	49642	52956	56148	59227	62199	65073	67854	70549	41
30	38927	42668	46255	49699	53011	56201	59277	62248	65120	67900	70593	42
45	38991	42729	46313	49755	53065	56253	59327	62297	65167	67946	70638	43
11 0	39054	42790	46372	49811	53119	56305	59378	62345	65214	67991	70682	44
15	39118	42851	46430	49867	53173	56357	59428	62394	65261	68037	70726	45
30	39182	42912	46489	49923	53227	56409	59478	62442	65308	68082	70770	46
45	39245	42973	46547	49979	53281	56461	59529	62491	65355	68128	70814	47
12 0	39309	43034	46605	50036	53335	56513	59579	62540	65402	68173	70858	48
15	39372	43095	46664	50092	53389	56565	59629	62588	65449	68219	70902	49
30	39435	43155	46722	50148	53443	56617	59679	62636	65496	68264	70946	50
45	39499	43216	46780	50204	53497	56669	59729	62685	65543	68309	70990	51
13 0	39562	43277	46838	50259	53550	56721	59779	62733	65590	68355	71034	52
15	39625	43337	46896	50315	53604	56773	59829	62782	65637	68400	71078	53
30	39688	43398	46955	50371	53658	56825	59879	62830	65683	68445	71122	54
45	39752	43458	47013	50427	53712	56876	59929	62878	65730	68491	71166	55
14 0	39815	43519	47071	50483	53765	56928	59979	62927	65777	68536	71210	56
15	39878	43579	47129	50539	53819	56980	60029	62975	65824	68581	71254	57
30	39941	43639	47187	50594	53873	57032	60079	63023	65870	68627	71298	58
45	40004	43700	47245	50650	53926	57083	60129	63071	65917	68672	71341	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 64.	Parts	4	9	13	17	21	26	30	34	38	43	47	51	55	60	64
D. 45.	Parts	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45

LOG. SINE SQUARE

	8°			9°				10°				
	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	
	0h 33m	0h 34m	0h 35m	0h 36m	0h 37m	0h 38m	0h 39m	0h 40m	0h 41m	0h 42m	0h 43m	s.
′ ″	7.	7.	7.	7.	7.	7.	7.	7.	7.	7.	7.	
0 0	71385	73974	76487	78929	81303	83615	85866	88059	90198	92286	94324	0
15	71429	74016	76528	78969	81342	83653	85903	88095	90234	92320	94357	1
30	71473	74059	76569	79009	81382	83691	85940	88131	90269	92354	94391	2
45	71516	74101	76610	79049	81421	83729	85977	88167	90304	92389	94424	3
1 0	71560	74143	76652	79089	81459	83767	86014	88203	90339	92423	94458	4
15	71604	74186	76693	79129	81498	83804	86050	88239	90374	92457	94491	5
30	71648	74228	76734	79169	81537	83842	86087	88276	90409	92492	94525	6
45	71691	74271	76775	79209	81576	83880	86124	88312	90445	92526	94558	7
2 0	71735	74313	76816	79249	81615	83918	86161	88348	90480	92560	94592	8
15	71778	74355	76857	79289	81654	83956	86198	88383	90515	92595	94625	9
30	71822	74398	76898	79329	81693	83994	86235	88419	90550	92629	94659	10
45	71866	74440	76940	79369	81732	84032	86272	88455	90585	92663	94692	11
3 0	71909	74482	76981	79409	81771	84070	86309	88491	90620	92697	94726	12
15	71953	74524	77022	79449	81810	84107	86346	88527	90655	92731	94759	13
30	71996	74567	77063	79489	81848	84145	86382	88563	90690	92766	94792	14
45	72040	74609	77104	79529	81887	84183	86419	88599	90725	92800	94826	15
4 0	72083	74651	77145	79568	81926	84221	86456	88635	90760	92834	94859	16
15	72126	74693	77186	79608	81965	84258	86493	88671	90795	92868	94892	17
30	72170	74735	77227	79648	82003	84296	86530	88707	90830	92902	94926	18
45	72213	74777	77267	79688	82042	84334	86566	88742	90865	92936	94959	19
5 0	72257	74819	77308	79728	82081	84372	86603	88778	90900	92970	94992	20
15	72300	74861	77349	79767	82119	84409	86640	88814	90935	93005	95026	21
30	72343	74904	77390	79807	82158	84447	86676	88850	90970	93039	95059	22
45	72387	74946	77431	79847	82197	84484	86713	88885	91005	93073	95092	23
6 0	72430	74988	77472	79886	82235	84522	86750	88921	91039	93107	95126	24
15	72473	75030	77513	79926	82274	84560	86786	88957	91074	93141	95159	25
30	72516	75072	77553	79966	82313	84597	86823	88993	91109	93175	95192	26
45	72560	75114	77594	80005	82351	84635	86860	89028	91144	93209	95225	27
7 0	72603	75155	77635	80045	82390	84672	86896	89064	91179	93243	95259	28
15	72646	75197	77676	80085	82428	84710	86933	89100	91214	93277	95292	29
30	72689	75239	77716	80124	82467	84747	86969	89135	91248	93311	95325	30
45	72732	75281	77757	80164	82505	84785	87006	89171	91283	93345	95358	31
8 0	72775	75323	77798	80203	82544	84822	87042	89207	91318	93379	95391	32
15	72818	75365	77838	80243	82582	84860	87079	89242	91353	93413	95424	33
30	72861	75407	77879	80282	82621	84897	87115	89278	91387	93447	95458	34
45	72904	75448	77920	80322	82659	84935	87152	89314	91422	93480	95491	35
9 0	72947	75490	77960	80361	82698	84972	87188	89349	91457	93514	95524	36
15	72990	75532	78001	80401	82736	85010	87225	89385	91492	93548	95557	37
30	73033	75574	78041	80440	82774	85047	87261	89420	91526	93582	95590	38
45	73076	75615	78082	80480	82813	85084	87298	89456	91561	93616	95623	39
10 0	73119	75657	78122	80519	82851	85122	87334	89491	91596	93650	95656	40
15	73162	75699	78163	80558	82889	85159	87371	89527	91630	93684	95689	41
30	73205	75740	78203	80598	82928	85196	87407	89562	91665	93717	95722	42
45	73248	75782	78244	80637	82966	85234	87443	89598	91699	93751	95755	43
11 0	73291	75824	78284	80677	83004	85271	87480	89633	91734	93785	95788	44
15	73334	75865	78325	80716	83043	85308	87516	89668	91769	93819	95821	45
30	73377	75907	78365	80755	83081	85346	87552	89704	91803	93852	95854	46
45	73419	75948	78405	80794	83119	85383	87589	89740	91838	93886	95887	47
12 0	73462	75990	78446	80834	83157	85420	87625	89775	91872	93920	95920	48
15	73505	76031	78486	80873	83196	85457	87661	89810	91907	93954	95953	49
30	73548	76073	78526	80912	83234	85494	87697	89846	91941	93987	95986	50
45	73590	76114	78567	80951	83272	85532	87734	89881	91976	94021	96019	51
13 0	73633	76156	78607	80991	83310	85569	87770	89916	92010	94055	96052	52
15	73676	76197	78647	81030	83348	85606	87806	89952	92045	94088	96085	53
30	73718	76239	78688	81069	83386	85643	87842	89987	92079	94122	96118	54
45	73761	76280	78728	81108	83424	85680	87878	90022	92114	94156	96150	55
14 0	73803	76321	78768	81147	83462	85717	87915	90057	92148	94189	96183	56
15	73846	76363	78808	81186	83501	85754	87951	90093	92183	94223	96216	57
30	73889	76404	78848	81225	83539	85791	87987	90128	92217	94257	96249	58
45	73931	76445	78889	81264	83577	85829	88023	90163	92251	94290	96282	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 41	Parts	3	6	9	11	14	17	20	23	26	29	32	34	37	40	43
D. 33	Parts	2	4	7	9	11	13	15	18	20	22	24	26	29	31	33

LOG SINE SQUARE

	11°				12°				13°			
	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	
	0ʰ 44ᵐ	0ʰ 45ᵐ	0ʰ 46ᵐ	0ʰ 47ᵐ	0ʰ 48ᵐ	0ʰ 49ᵐ	0ʰ 50ᵐ	0ʰ 51ᵐ	0ʰ 52ᵐ	0ʰ 53ᵐ	0ʰ 54ᵐ	s.
′ ′	7·9		8·0	8·0	8·0	8·0	8·0	8·	8·1	8·1	8·1	
0 0	63146	7·982604	01632	20248	38469	56312	73792	090922	07717	24190	40352	0
15	63474	7·982925	01945	20555	38770	56606	74080	091205	07995	24462	40619	1
30	63801	7·983245	02259	20862	39070	56900	74368	091487	08272	24734	40886	2
45	64129	7·983565	02572	21168	39370	57194	74656	091770	08549	25006	41152	3
1 0	64457	7·983886	02886	21475	39670	57488	74944	092052	08826	25277	41419	4
15	64784	7·984206	03199	21781	39970	57782	75232	092334	09102	25549	41685	5
30	65111	7·984526	03512	22087	40270	58076	75520	092617	09379	25820	41952	6
45	65439	7·984846	03825	22394	40570	58370	75808	092899	09655	26091	42218	7
2 0	65766	7·985166	04137	22700	40870	58663	76095	093181	09932	26363	42484	8
15	66093	7·985485	04450	23006	41169	58957	76383	093463	10209	26634	42750	9
30	66420	7·985805	04763	23312	41469	59250	76670	093744	10485	26905	43016	10
45	66746	7·986124	05075	23617	41768	59543	76958	094026	10761	27176	43282	11
3 0	67073	7·986443	05388	23923	42067	59836	77245	094308	11037	27447	43557	12
15	67399	7·986762	05700	24229	42367	60129	77532	094589	11314	27718	43814	13
30	67726	7·987082	06012	24534	42666	60422	77819	094871	11590	27989	44080	14
45	68052	7·987400	06324	24839	42965	60715	78106	095152	11865	28259	44345	15
4 0	68378	7·987719	06636	25145	43264	61008	78393	095433	12141	28530	44611	16
15	68704	7·988038	06947	25450	43562	61301	78680	095714	12417	28800	44876	17
30	69030	7·988357	07259	25755	43861	61593	78967	095995	12693	29071	45142	18
45	69355	7·988675	07571	26060	44159	61886	79253	096276	12968	29341	45407	19
5 0	69681	7·988994	07882	26365	44458	62178	79540	096557	13244	29611	45672	20
15	70006	7·989312	08193	26669	44756	62470	79826	096838	13519	29882	45937	21
30	70332	7·989630	08505	26974	45055	62763	80113	097119	13794	30152	46203	22
45	70657	7·989948	08816	27278	45353	63055	80399	097399	14069	30422	46468	23
6 0	70982	7·990266	09127	27583	45651	63347	80685	097680	14345	30692	46732	24
15	71307	7·990583	09438	27887	45949	63638	80971	097960	14620	30961	46997	25
30	71632	7·990901	09748	28191	46247	63930	81257	098241	14895	31231	47262	26
45	71956	7·991219	10059	28495	46544	64222	81543	098521	15169	31501	47527	27
7 0	72281	7·991536	10370	28799	46842	64513	81828	098801	15444	31770	47791	28
15	72606	7·991853	10680	29103	47139	64805	82114	099081	15719	32040	48056	29
30	72930	7·992171	10990	29407	47437	65096	82400	099361	15993	32309	48320	30
45	73254	7·992488	11300	29710	47734	65387	82685	099641	16268	32579	48585	31
8 0	73578	7·992805	11611	30014	48031	65679	82970	099921	16542	32848	48849	32
15	73902	7·993121	11920	30317	48328	65970	83256	100200	16817	33117	49113	33
30	74226	7·993438	12230	30621	48626	66261	83541	100480	17091	33386	49377	34
45	74550	7·993755	12540	30924	48922	66551	83826	100759	17365	33655	49641	35
9 0	74873	7·994071	12850	31227	49219	66842	84111	101039	17639	33924	49905	36
15	75197	7·994387	13159	31530	49516	67133	84396	101318	17913	34193	50169	37
30	75520	7·994704	13469	31833	49813	67424	84681	101597	18187	34461	50433	38
45	75844	7·995020	13778	32135	50109	67714	84965	101876	18461	34730	50696	39
10 0	76167	7·995336	14087	32438	50405	68004	85250	102156	18734	34999	50960	40
15	76490	7·995652	14396	32741	50702	68295	85534	102434	19008	35267	51223	41
30	76813	7·995968	14705	33043	50998	68585	85819	102713	19281	35535	51487	42
45	77135	7·996283	15014	33345	51294	68875	86103	102992	19555	35804	51750	43
11 0	77458	7·996599	15323	33648	51590	69165	86387	103271	19828	36072	52013	44
15	77780	7·996914	15631	33950	51886	69455	86671	103549	20102	36340	52277	45
30	78103	7·997230	15940	34252	52182	69745	86956	103828	20375	36608	52540	46
45	78425	7·997545	16248	34554	52477	70034	87239	104106	20648	36876	52803	47
12 0	78747	7·997860	16557	34856	52773	70324	87523	104385	20921	37144	53066	48
15	79069	7·998175	16865	35157	53068	70613	87807	104663	21194	37412	53328	49
30	79391	7·998490	17173	35459	53364	70903	88091	104941	21467	37679	53591	50
45	79713	7·998804	17481	35760	53659	71192	88374	105219	21739	37947	53854	51
13 0	80035	7·999119	17789	36062	53954	71481	88658	105497	22012	38215	54117	52
15	80356	7·999433	18097	36363	54249	71770	88941	105775	22285	38482	54379	53
30	80678	7·999748	18404	36664	54544	72059	89224	106053	22557	38750	54642	54
45	80999	8·000062	18712	36965	54839	72348	89508	106330	22829	39017	54904	55
14 0	81320	8·000376	19019	37266	55134	72637	89791	106608	23102	39284	55166	56
15	81641	8·000690	19326	37567	55428	72926	90074	106885	23373	39551	55429	57
30	81962	8·001004	19634	37868	55723	73215	90357	107163	23645	39818	55691	58
45	82283	8·001318	19941	38169	56018	73503	90639	107441	23918	40085	55953	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 324.	Parts	22	43	65	86	108	130	151	173	194	216	238	259	281	302	324
D. 264.	Parts	18	35	53	70	88	106	123	141	158	176	194	211	229	246	264

LOG. SINE SQUARE

	13°	14°				15°				16°		
	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	
	0h 55m	0h 56m	0h 57m	0h 58m	0h 59m	1h 0m	1h 1m	1h 2m	1h 3m	1h 4m	1h 5m	s.
′ ″	8·1	8·1	8·	8·2	8·2	8·2	8·2	8·2	8·2	8·	8·3	
0 0	56215	71788	187085	02112	16879	31395	45669	59708	73519	287111	00488	0
15	56477	72046	187337	02360	17123	31635	45905	59940	73748	287335	00710	1
30	56738	72303	187590	02608	17367	31875	46141	60172	73976	287560	00931	2
45	57000	72560	187842	02856	17611	32115	46376	60404	74204	287784	01152	3
1 0	57262	72817	188095	03104	17854	32354	46612	60636	74432	288009	01373	4
15	57524	73074	188347	03352	18098	32594	46848	60867	74660	288233	01594	5
30	57785	73331	188599	03600	18342	32833	47083	61099	74888	288458	01815	6
45	58046	73588	188851	03848	18585	33073	47319	61331	75116	288682	02035	7
2 0	58308	73844	189104	04095	18829	33312	47554	61562	75344	288906	02256	8
15	58569	74101	189356	04343	19072	33552	47790	61794	75572	289131	02477	9
30	58830	74357	189608	04591	19316	33791	48025	62025	75800	289355	02698	10
45	59091	74614	189859	04838	19559	34030	48260	62257	76027	289579	02918	11
3 0	59352	74870	190111	05086	19802	34269	48495	62488	76255	289803	03139	12
15	59613	75126	190363	05333	20045	34508	48730	62719	76483	290027	03359	13
30	59874	75382	190615	05580	20288	34747	48965	62951	76710	290251	03580	14
45	60135	75639	190866	05827	20531	34986	49200	63182	76938	290475	03800	15
4 0	60396	75895	191118	06074	20774	35225	49435	63413	77165	290699	04021	16
15	60656	76150	191369	06322	21017	35464	49670	63643	77392	290922	04241	17
30	60917	76406	191620	06569	21263	35703	49905	63875	77620	291146	04461	18
45	61177	76662	191872	06816	21503	35941	50140	64106	77847	291370	04681	19
5 0	61438	76918	192123	07062	21745	36180	50374	64337	78074	291593	04901	20
15	61698	77174	192374	07309	21988	36418	50609	64567	78301	291817	05121	21
30	61958	77429	192625	07556	22230	36656	50843	64798	78528	292040	05341	22
45	62218	77685	192876	07803	22473	36895	51078	65029	78755	292264	05561	23
6 0	62478	77940	193127	08049	22715	37133	51312	65259	78982	292487	05781	24
15	62738	78195	193378	08296	22957	37372	51547	65490	79209	292710	06001	25
30	62998	78451	193629	08542	23200	37610	51781	65720	79436	292933	06221	26
45	63258	78706	193879	08788	23442	37848	52015	65951	79662	293157	06440	27
7 0	63518	78961	194130	09035	23684	38086	52249	66181	79889	293380	06660	28
15	63778	79216	194381	09281	23926	38324	52483	66411	80116	293603	06880	29
30	64037	79471	194631	09527	24168	38562	52717	66642	80342	293826	07099	30
45	64297	79726	194881	09773	24410	38800	52951	66872	80569	294049	07319	31
8 0	64556	79981	195132	10019	24652	39038	53185	67102	80795	294272	07538	32
15	64816	80235	195382	10265	24893	39275	53419	67332	81021	294494	07757	33
30	65075	80490	195632	10511	25135	39513	53653	67552	81248	294717	07977	34
45	65334	80745	195882	10757	25377	39751	53886	67792	81474	294940	08196	35
9 0	65593	80999	196132	11003	25618	39988	54120	68022	81700	295162	08415	36
15	65852	81254	196382	11248	25860	40226	54354	68251	81926	295385	08634	37
30	66111	81508	196632	11494	26101	40463	54587	68481	82152	295608	08853	38
45	66370	81762	196882	11739	26343	40700	54820	68711	82378	295830	09072	39
10 0	66629	82016	197132	11985	26584	40938	55054	68940	82604	296052	09291	40
15	66888	82260	197382	12230	26825	41175	55287	69170	82830	296275	09510	41
30	67146	82525	197631	12475	27066	41412	55520	69399	83056	296497	09729	42
45	67405	82778	197881	12721	27307	41649	55754	69629	83282	296719	09948	43
11 0	67663	83032	198130	12966	27548	41886	55987	69858	83507	296941	10167	44
15	67922	83286	198380	13211	27789	42123	56220	70087	83733	297164	10385	45
30	68180	83540	198629	13456	28030	42360	56453	70317	83957	297386	10604	46
45	68439	83794	198878	13701	28271	42597	56686	70546	84184	297608	10823	47
12 0	68697	84047	199127	13946	28512	42833	56919	70775	84410	297830	11041	48
15	68955	84301	199376	14191	28752	43070	57151	71004	84635	298051	11260	49
30	69213	84554	199625	14435	28993	43307	57384	71234	84860	298273	11478	50
45	69471	84807	199874	14680	29234	43543	57617	71462	85086	298495	11696	51
13 0	69729	85061	200123	14925	29474	43780	57849	71691	85311	298717	11915	52
15	69986	85314	200372	15169	29714	44016	58082	71919	85536	298938	12133	53
30	70244	85567	200621	15414	29955	44252	58314	72148	85761	299160	12351	54
45	70502	85819	200869	15658	30195	44489	58547	72377	85986	299381	12569	55
14 0	70759	86070	201118	15902	30435	44725	58779	72606	86211	299603	12787	56
15	71017	86326	201366	16147	30675	44961	59011	72834	86436	299824	13005	57
30	71274	86579	201615	16391	30915	45197	59244	73063	86661	300046	13223	58
45	71531	86832	201863	16635	31155	45433	59476	73291	86886	300267	13441	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 260.	Parts	17	35	52	69	87	104	121	139	156	173	191	208	225	243	260
D. 220.	Parts	15	29	44	59	73	88	103	117	132	147	161	176	191	206	220

LOG. SINE SQUARE

	16°		17°				18°				19°	
	30′	45′	0′	15′	30	45′	0′	15′	30′	45′	0′	
	1h 6m	1h 7m	1h 8m	1h 9m	1h 10m	1h 11m	1h 12m	1h 13m	1h 14m	1h 15m	1h 16m	s.
′ ″	8·3	8·3	8·3	8·3	8·3	8·3	8·	8·4	8·4	8·4	8·4	
0 0	13659	26629	39404	51990	64392	76615	388665	00546	12262	23818	35218	0
15	13877	26844	39615	52198	64597	76817	388864	00742	12456	24009	35407	1
30	14095	27058	39827	52406	64802	77020	389064	00939	12650	24201	35596	2
45	14312	27272	40038	52614	65007	77222	389263	01135	12843	24392	35784	3
1 0	14530	27487	40249	52822	65212	77424	389462	01332	13037	24583	35973	4
15	14748	27701	40460	53030	65417	77626	389661	01528	13231	24774	36161	5
30	14965	27915	40671	53238	65622	77828	389860	01724	13425	24965	36350	6
45	15182	28129	40882	53446	65827	78030	390059	01921	13618	25156	36538	7
2 0	15400	28344	41093	53654	66032	78232	390259	02117	13812	25347	36727	8
15	15617	28558	41304	53862	66237	78434	390458	02313	14005	25538	36915	9
30	15835	28772	41515	54070	66441	78635	390657	02510	14199	25729	37104	10
45	16052	28986	41726	54277	66646	78837	390855	02706	14392	25920	37292	11
3 0	16269	29200	41936	54485	66851	79039	391054	02902	14586	26110	37480	12
15	16486	29413	42147	54692	67055	79241	391253	03098	14779	26301	37668	13
30	16703	29627	42358	54900	67260	79442	391452	03294	14972	26492	37857	14
45	16920	29841	42568	55107	67464	79644	391651	03490	15166	26683	38045	15
4 0	17137	30055	42779	55315	67669	79845	391849	03686	15359	26873	38233	16
15	17354	30268	42989	55522	67873	80047	392048	03882	15552	27064	38421	17
30	17571	30482	43200	55730	68077	80248	392247	04077	15745	27254	38609	18
45	17788	30695	43410	55937	68282	80450	392445	04273	15938	27445	38797	19
5 0	18004	30909	43620	56144	68486	80651	392644	04469	16131	27635	38985	20
15	18221	31122	43830	56351	68690	80852	392842	04665	16324	27826	39173	21
30	18438	31336	44041	56558	68894	81053	393040	04860	16518	28016	39360	22
45	18654	31549	44251	56765	69098	81255	393239	05056	16710	28206	39548	23
6 0	18871	31762	44461	56973	69302	81456	393437	05252	16903	28397	39736	24
15	19087	31975	44671	57179	69506	81657	393635	05447	17096	28587	39924	25
30	19304	32189	44881	57386	69710	81858	393834	05643	17289	28777	40111	26
45	19520	32402	45091	57593	69914	82059	394032	05838	17482	28967	40299	27
7 0	19736	32615	45301	57800	70118	82260	394230	06033	17674	29157	40486	28
15	19953	32828	45511	58007	70322	82461	394428	06229	17867	29347	40674	29
30	20169	33041	45720	58214	70526	82661	394626	06424	18060	29537	40862	30
45	20385	33254	45930	58420	70729	82862	394824	06619	18252	29727	41049	31
8 0	20601	33466	46140	58627	70933	83063	395022	06814	18445	29917	41236	32
15	20817	33679	46349	58833	71137	83264	395220	07009	18637	30107	41424	33
30	21033	33892	46559	59040	71340	83464	395418	07205	18830	30297	41611	34
45	21249	34105	46768	59246	71544	83665	395615	07400	19022	30487	41798	35
9 0	21465	34317	46978	59453	71747	83866	395813	07595	19214	30677	41986	36
15	21681	34530	47187	59659	71950	84066	396011	07790	19407	30866	42173	37
30	21896	34742	47397	59866	72154	84267	396209	07985	19599	31056	42360	38
45	22112	34955	47606	60072	72357	84467	396406	08179	19791	31246	42547	39
10 0	22328	35167	47815	60278	72560	84667	396604	08374	19983	31435	42734	40
15	22543	35379	48025	60484	72764	84868	396801	08569	20176	31625	42921	41
30	22759	35592	48234	60690	72967	85068	396999	08764	20368	31814	43108	42
45	22974	35804	48443	60896	73170	85268	397196	08959	20560	32004	43295	43
11 0	23190	36016	48652	61102	73373	85468	397394	09153	20752	32193	43482	44
15	23405	36228	48861	61308	73576	85668	397591	09348	20944	32383	43669	45
30	23620	36440	49070	61514	73779	85869	397788	09542	21136	32572	43856	46
45	23836	36652	49279	61720	73982	86069	397985	09737	21328	32761	44043	47
12 0	24051	36864	49488	61926	74185	86269	398183	09931	21519	32951	44229	48
15	24266	37076	49696	62132	74387	86469	398380	10126	21711	33140	44416	49
30	24481	37288	49905	62338	74590	86668	398577	10320	21903	33329	44603	50
45	24696	37500	50114	62543	74793	86868	398774	10515	22095	33518	44789	51
13 0	24911	37712	50323	62749	74996	87068	398971	10709	22286	33707	44976	52
15	25126	37924	50531	62954	75198	87268	399168	10963	22478	33896	45162	53
30	25341	38135	50740	63160	75401	87468	399365	11097	22669	34085	45349	54
45	25556	38347	50948	63365	75603	87667	399562	11292	22861	34274	45535	55
14 0	25771	38558	51157	63571	75806	87867	399759	11486	23053	34463	45722	56
15	25985	38770	51365	63776	76008	88066	399955	11680	23244	34652	45908	57
30	26200	38981	51573	63981	76211	88266	400152	11874	23435	34841	46095	58
45	26415	39193	51782	64187	76413	88465	400349	12068	23627	35030	46281	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 216.	Parts	14	29	43	58	72	86	101	115	130	144	158	173	187	202	216
D. 187.	Parts	12	25	37	50	62	75	87	100	112	125	137	150	162	175	187

LOG. SINE SQUARE

	19°			20°				21°				
	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	
	1h 17m	1h 18m	1h 19m	1h 20m	1h 21m	1h 22m	1h 23m	1h 24m	1h 25m	1h 26m	1h 27m	s.
′ ″	8·4	8·4	8·4	8·4	8·	8·5	8·5	8·5	8·5	8·5	8·5	
0 0	46467	57568	68524	79340	490019	00564	10979	21266	31429	41470	51392	0
15	46653	57752	68706	79520	490196	00739	11151	21436	31597	41636	51556	1
30	46839	57935	68887	79699	490373	00914	11324	21607	31765	41802	51720	2
45	47026	58119	69068	79878	490550	01088	11496	21777	31934	41968	51885	3
1 0	47212	58303	69250	80057	490726	01263	11669	21947	32102	42135	52049	4
15	47398	58486	69431	80235	490903	01437	11841	22118	32270	42301	52213	5
30	47584	58670	69612	80414	491080	01612	12013	22288	32438	42467	52377	6
45	47770	58853	69793	80593	491256	01786	12186	22458	32606	42633	52542	7
2 0	47956	59037	69975	80772	491433	01961	12358	22628	32774	42799	52706	8
15	48142	59220	70156	80951	491609	02135	12530	22798	32942	42965	52870	9
30	48327	59404	70337	81130	491786	02309	12702	22968	33111	43131	53034	10
45	48513	59587	70518	81308	491962	02483	12874	23138	33278	43297	53198	11
3 0	48699	59771	70699	81487	492139	02658	13047	23308	33446	43463	53362	12
15	48885	59954	70880	81666	492315	02832	13219	23478	33614	43629	53526	13
30	49070	60137	71061	81844	492492	03006	13391	23648	33782	43795	53690	14
45	49256	60320	71241	82023	492668	03180	13563	23818	33950	43961	53854	15
4 0	49442	60504	71422	82201	492844	03354	13735	23988	34118	44127	54018	16
15	49627	60687	71603	82380	493021	03528	13906	24158	34286	44293	54182	17
30	49813	60870	71784	82558	493197	03702	14078	24328	34454	44459	54346	18
45	49998	61053	71964	82737	493373	03876	14250	24498	34621	44624	54509	19
5 0	50184	61236	72145	82915	493549	04050	14422	24667	34789	44790	54673	20
15	50369	61419	72326	83093	493725	04224	14594	24837	34957	44956	54837	21
30	50554	61602	72506	83272	493901	04398	14766	25007	35124	45121	55001	22
45	50740	61785	72687	83450	494077	04572	14937	25176	35292	45287	55164	23
6 0	50925	61968	72868	83628	494253	04746	15109	25346	35459	45453	55328	24
15	51110	62150	73048	83806	494429	04919	15281	25515	35627	45618	55491	25
30	51295	62333	73228	83985	494605	05093	15452	25685	35795	45784	55655	26
45	51480	62516	73409	84163	494781	05267	15624	25854	35962	45949	55819	27
7 0	51666	62699	73589	84341	494957	05441	15795	26024	36129	46115	55982	28
15	51851	62881	73769	84519	495133	05614	15967	26193	36297	46280	56146	29
30	52036	63064	73950	84697	495308	05788	16138	26363	36464	46445	56309	30
45	52221	63247	74130	84875	495484	05961	16310	26532	36631	46611	56472	31
8 0	52406	63429	74310	85053	495660	06135	16481	26701	36799	46776	56636	32
15	52591	63612	74490	85231	495835	06308	16652	26871	36966	46941	56799	33
30	52775	63794	74671	85408	496011	06482	16824	27040	37133	47107	56963	34
45	52960	63976	74851	85586	496187	06655	16995	27209	37300	47272	57126	35
9 0	53145	64160	75031	85764	496362	06829	17166	27378	37468	47437	57289	36
15	53330	64341	75211	85942	496538	07002	17338	27548	37635	47602	57452	37
30	53515	64524	75391	86119	496713	07175	17509	27717	37802	47767	57615	38
45	53699	64706	75571	86297	496889	07349	17680	27886	37969	47932	57779	39
10 0	53884	64888	75751	86475	497064	07522	17851	28055	38136	48097	57942	40
15	54068	65070	75930	86652	497239	07695	18022	28224	38303	48262	58105	41
30	54253	65252	76110	86830	497415	07868	18193	28393	38470	48427	58268	42
45	54437	65434	76290	87007	497590	08041	18364	28562	38637	48592	58431	43
11 0	54622	65617	76470	87185	497765	08214	18535	28731	38804	48757	58594	44
15	54806	65799	76649	87362	497941	08387	18706	28899	38971	48922	58757	45
30	54991	65981	76829	87540	498116	08560	18877	29068	39137	49087	58920	46
45	55175	66162	77009	87717	498291	08733	19048	29237	39304	49252	59083	47
12 0	55359	66344	77188	87894	498466	08906	19219	29406	39471	49417	59246	48
15	55544	66526	77368	88072	498641	09079	19390	29575	39638	49581	59408	49
30	55728	66708	77547	88249	498816	09252	19560	29743	39804	49746	59571	50
45	55912	66890	77727	88426	498991	09425	19731	29912	39971	49911	59734	51
13 0	56096	67072	77906	88603	499166	09598	19902	30081	40138	50076	59897	52
15	56280	67253	78086	88780	499341	09771	20072	30249	40304	50240	60059	53
30	56464	67435	78265	88958	499516	09943	20243	30418	40471	50405	60222	54
45	56648	67617	78444	89135	499691	10116	20414	30586	40637	50569	60385	55
14 0	56832	67798	78624	89312	499866	10289	20584	30755	40804	50734	60548	56
15	57016	67980	78803	89489	500040	10461	20755	30923	40970	50898	60710	57
30	57200	68161	78982	89666	500215	10634	20925	31092	41137	51063	60873	58
45	57384	68343	79161	89842	500390	10807	21096	31260	41303	51227	61035	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 185.	Parts	12	25	37	49	62	74	85	99	111	123	136	148	160	173	185
D. 164.	Parts	11	22	33	44	55	66	76	87	98	109	120	131	142	153	164

LOG. SINE SQUARE

m	s	22° 0′ 1ʰ 28ᵐ	22° 15′ 1ʰ 29ᵐ	22° 30′ 1ʰ 30ᵐ	22° 45′ 1ʰ 31ᵐ	23° 0′ 1ʰ 32ᵐ	23° 15′ 1ʰ 33ᵐ	23° 30′ 1ʰ 34ᵐ	23° 45′ 1ʰ 35ᵐ	24° 0′ 1ʰ 36ᵐ	24° 15′ 1ʰ 37ᵐ	24° 30′ 1ʰ 38ᵐ	s
′	″	8·5	8·5	8·5	8·5	8·	8·6	8·6	8·6	8·6	8·6	8·6	
0	0	61198	70890	80471	89944	599311	08573	17734	26795	35758	44625	53399	0
	15	61360	71051	80630	90101	599466	08726	17885	26945	35906	44772	53545	1
	30	61523	71211	80789	90258	599621	08880	18037	27095	36055	44919	53690	2
	45	61685	71372	80948	90415	599776	09033	18189	27245	36203	45066	53836	3
1	0	61847	71532	81106	90572	599931	09187	18341	27395	36352	45213	53981	4
	15	62010	71693	81265	90729	600086	09340	18492	27545	36500	45360	54126	5
	30	62172	71853	81424	90886	600242	09494	18644	27695	36649	45507	54272	6
	45	62334	72014	81582	91042	600397	09647	18796	27845	36797	45654	54417	7
2	0	62497	72174	81741	91199	600552	09800	18947	27995	36946	45801	54562	8
	15	62659	72334	81899	91356	600707	09954	19099	28145	37094	45947	54707	9
	30	62821	72495	82058	91512	600862	10107	19251	28295	37242	46094	54853	10
	45	62983	72655	82216	91669	601016	10260	19402	28445	37391	46241	54998	11
3	0	63145	72815	82375	91826	601171	10413	19554	28595	37539	46388	55143	12
	15	63307	72975	82533	91982	601326	10566	19705	28745	37687	46534	55288	13
	30	63469	73136	82691	92139	601481	10720	19857	28895	37835	46681	55433	14
	45	63631	73296	82850	92296	601636	10873	20008	29044	37984	46828	55578	15
4	0	63793	73456	83008	92452	601791	11026	20160	29194	38132	46974	55723	16
	15	63955	73616	83166	92609	601945	11179	20311	29344	38280	47121	55868	17
	30	64117	73776	83325	92765	602100	11332	20462	29494	38428	47267	56014	18
	45	64279	73936	83483	92922	602255	11485	20614	29643	38576	47414	56159	19
5	0	64441	74096	83641	93078	602410	11638	20765	29793	38724	47560	56304	20
	15	64603	74256	83799	93234	602564	11791	20916	29943	38872	47707	56448	21
	30	64765	74416	83957	93391	602719	11944	21067	30092	39020	47853	56593	22
	45	64926	74576	84115	93547	602873	12096	21219	30242	39168	48000	56738	23
6	0	65088	74736	84273	93703	603028	12249	21370	30391	39316	48146	56883	24
	15	65250	74896	84431	93860	603182	12402	21521	30541	39464	48293	57028	25
	30	65412	75056	84589	94016	603337	12555	21672	30690	39612	48439	57173	26
	45	65573	75215	84747	94172	603491	12708	21823	30840	39760	48585	57318	27
7	0	65735	75375	84905	94328	603646	12861	21974	30989	39908	48731	57462	28
	15	65896	75535	85063	94484	603800	13013	22125	31139	40056	48878	57607	29
	30	66058	75695	85221	94641	603955	13166	22276	31288	40203	49024	57752	30
	45	66219	75854	85379	94797	604109	13319	22427	31438	40351	49170	57896	31
8	0	66381	76014	85537	94953	604263	13471	22578	31587	40499	49316	58041	32
	15	66542	76173	85695	95109	604418	13624	22729	31736	40647	49463	58186	33
	30	66704	76333	85853	95265	604572	13776	22880	31886	40794	49609	58330	34
	45	66865	76493	86010	95421	604726	13929	23031	32035	40942	49755	58475	35
9	0	67027	76652	86168	95577	604880	14081	23182	32184	41090	49901	58620	36
	15	67188	76812	86326	95732	605035	14234	23333	32333	41237	50047	58764	37
	30	67349	76971	86483	95888	605189	14386	23484	32482	41385	50193	58909	38
	45	67510	77130	86641	96044	605343	14539	23634	32632	41532	50339	59053	39
10	0	67672	77290	86799	96200	605497	14691	23785	32781	41680	50485	59198	40
	15	67833	77449	86956	96356	605651	14844	23936	32930	41828	50631	59342	41
	30	67994	77609	87114	96512	605805	14996	24087	33079	41975	50777	59486	42
	45	68155	77768	87271	96667	605959	15148	24237	33228	42123	50923	59631	43
11	0	68316	77927	87429	96823	606113	15301	24388	33377	42270	51069	59775	44
	15	68477	78086	87586	96979	606267	15453	24539	33526	42417	51215	59919	45
	30	68639	78246	87743	97134	606421	15605	24689	33675	42565	51360	60064	46
	45	68880	78405	87901	97290	606575	15757	24840	33824	42712	51506	60208	47
12	0	68961	78564	88058	97446	606729	15910	24990	33973	42859	51652	60352	48
	15	69121	78723	88216	97601	606883	16062	25141	34122	43007	51798	60496	49
	30	69282	78882	88373	97757	607036	16214	25291	34271	43154	51943	60641	50
	45	69443	79041	88530	97912	607190	16366	25442	34419	43301	52089	60785	51
13	0	69604	79200	88687	98068	607344	16518	25592	34568	43449	52235	60929	52
	15	69765	79359	88845	98223	607498	16670	25742	34717	43596	52380	61073	53
	30	69926	79518	89002	98379	607651	16822	25893	34866	43743	52526	61217	54
	45	70087	79677	89159	98534	607805	16974	26043	35015	43890	52672	61361	55
14	0	70257	79836	89316	98689	607959	17126	26194	35163	44037	52817	61505	56
	15	70408	79995	89473	98845	608112	17278	26344	35312	44184	52963	61649	57
	30	70569	80154	89630	99000	608266	17430	26494	35461	44331	53108	61793	58
	45	70729	80313	89787	99155	608419	17582	26644	35609	44478	53254	61037	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 162	Parts	11	22	32	43	54	65	76	86	97	108	119	130	140	151	162
D. 145	Parts	10	19	29	39	48	58	68	77	87	97	106	116	126	135	145

LOG. SINE SQUARE

m s	24° 45′	25° 0′	25° 15′	25° 30′	25° 45′	26° 0′	26° 15′	26° 30′	26° 45′	27° 0′	27° 15′	s
	1h 39m	1h 40m	1h 41m	1h 42m	1h 43m	1h 44m	1h 45m	1h 46m	1h 47m	1h 48m	1h 49m	
	8·6	8·6	8·6	8·6	8·	8·7	8·7	8·7	8·7	8·7	8·7	
0 0	62081	70674	79177	87595	695927	04176	12343	20431	28439	36371	44226	0
15	62225	70816	79318	87734	696065	04313	12479	20565	28572	36502	44356	1
30	62369	70958	79459	87974	696203	04450	12614	20699	28705	36634	44486	2
45	62513	71101	79600	88013	696341	04586	12750	20833	28838	36765	44617	3
1 0	62657	71243	79741	88153	696479	04723	12885	20967	28970	36896	44747	4
15	62801	71385	79882	88292	696618	04860	13020	21101	29103	37028	44877	5
30	62945	71528	80023	88432	696756	04996	13156	21235	29236	37159	45007	6
45	63088	71670	80164	88571	696894	05133	13291	21369	29368	37291	45137	7
2 0	63232	71812	80305	88710	697032	05270	13426	21503	29501	37422	45268	8
15	63376	71955	80445	88850	697170	05406	13562	21637	29634	37554	45398	9
30	63520	72097	80586	88989	697308	05543	13697	21771	29766	37685	45528	10
45	63663	72239	80727	89129	697445	05679	13832	21905	29899	37816	45658	11
3 0	63807	72381	80868	89268	697583	05816	13967	22039	30032	37948	45788	12
15	63951	72523	81008	89407	697721	05952	14102	22173	30164	38079	45918	13
30	64094	72666	81149	89546	697859	06089	14238	22306	30297	38210	46048	14
45	64238	72808	81290	89686	697997	06225	14373	22440	30429	38341	46178	15
4 0	64381	72950	81430	89825	698135	06362	14508	22574	30562	38473	46308	16
15	64525	73092	81571	89964	698273	06498	14643	22708	30694	38604	46438	17
30	64668	73234	81711	90103	698410	06635	14778	22841	30827	38735	46568	18
45	64812	73376	81852	90242	698548	06771	14913	22975	30959	38866	46698	19
5 0	64955	73518	81993	90381	698686	06908	15048	23109	31092	38997	46828	20
15	65099	73660	82133	90520	698823	07044	15183	23242	31224	39128	46958	21
30	65242	73802	82274	90660	698961	07180	15318	23376	31356	39259	47087	22
45	65386	73944	82414	90799	699099	07316	15453	23510	31489	39391	47217	23
6 0	65529	74086	82555	90938	699237	07453	15588	23643	31621	39522	47347	24
15	65672	74227	82695	91077	699374	07589	15723	23777	31753	39653	47477	25
30	65816	74369	82835	91216	699512	07725	15858	23911	31886	39784	47607	26
45	65959	74511	82976	91355	699649	07861	15993	24044	32018	39915	47736	27
7 0	66102	74653	83116	91493	699787	07998	16127	24178	32150	40046	47866	28
15	66245	74795	83256	91632	699924	08134	16262	24311	32282	40177	47996	29
30	66389	74936	83397	91771	700062	08270	16397	24445	32414	40308	48126	30
45	66532	75078	83537	91910	700199	08406	16532	24578	32547	40438	48255	31
8 0	66675	75220	83677	92049	700337	08542	16667	24712	32679	40569	48385	32
15	66818	75361	83817	92188	700474	08678	16801	24845	32811	40700	48515	33
30	66961	75503	83958	92327	700612	08814	16936	24978	32943	40831	48644	34
45	67104	75645	84098	92465	700749	08950	17071	25112	33075	40962	48774	35
9 0	67247	75786	84238	92604	700886	09086	17205	25245	33207	41093	48903	36
15	67390	75928	84378	92743	701024	09222	17340	25378	33339	41224	49033	37
30	67533	76069	84518	92881	701161	09358	17475	25512	33471	41354	49162	38
45	67676	76211	84658	93020	701298	09494	17609	25645	33603	41485	49292	39
10 0	67819	76352	84798	93159	701436	09630	17744	25778	33735	41616	49421	40
15	67962	76494	84938	93297	701573	09766	17878	25912	33867	41747	49551	41
30	68105	76635	85078	93436	701710	09902	18013	26045	33999	41877	49680	42
45	68248	76777	85218	93575	701847	10038	18147	26178	34131	42008	49810	43
11 0	68391	76918	85358	93713	701984	10173	18282	26311	34263	42138	49939	44
15	68534	77060	85498	93852	702121	10309	18416	26444	34395	42269	50068	45
30	68677	77201	85638	93990	702259	10445	18551	26578	34527	42400	50198	46
45	68819	77342	85778	94129	702396	10581	18685	26711	34659	42530	50327	47
12 0	68962	77484	85918	94267	702533	10716	18820	26844	34790	42661	50457	48
15	69105	77625	86058	94406	702670	10852	18954	26977	34922	42791	50586	49
30	69248	77766	86198	94544	702807	10988	19088	27110	35054	42922	50715	50
45	69390	77907	86377	94682	702944	11123	19223	27243	35186	43052	50844	51
13 0	69533	78049	86477	94821	703081	11259	19357	27376	35317	43183	50974	52
15	69676	78190	86617	94959	703218	11395	19491	27509	35449	43313	51103	53
30	69818	78331	86757	95097	703355	11530	19626	27642	35581	43444	51232	54
45	69961	78472	86896	95236	703492	11666	19760	27775	35712	43574	51361	55
14 0	70103	78613	87036	95374	703629	11801	19894	27908	35844	43705	51490	56
15	70246	78754	87176	95512	703765	11937	20028	28041	35976	43835	51619	57
30	70389	78895	87315	95651	703902	12073	20162	28174	36107	43965	51749	58
45	70531	79036	87455	95789	704039	12208	20297	28306	36239	44096	51878	59

	Sec.	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"	12"	13"	14"	15"
D 143.	Parts	9	19	28	38	48	57	67	76	86	95	105	114	123	133	143
D 130.	Parts	9	17	26	35	43	52	61	69	78	87	95	104	113	121	130

LOG. SINE SQUARE

	27°		28°				29°				30°	
	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	
	1h 50m	1h 51m	1h 52m	1h 53m	1h 54m	1h 55m	1h 56m	1h 57m	1h 58m	1h 59m	2h 0m	s.
′ ″	8·7	8·7	8·7	8·7	8·7	8·7	8·	8·8	8·8	8·8	8·8	
0 0	52007	59715	67350	74916	82411	89839	797199	04494	11723	18889	25992	0
15	52136	59842	67477	75041	82536	89962	797321	04615	11843	19008	26110	1
30	52265	59970	67604	75167	82660	90085	797443	04736	11963	19127	26228	2
45	52394	60098	67730	75292	82784	90208	797566	04857	12083	19246	26346	3
1 0	52523	60226	67857	75417	82909	90332	797688	04978	12203	19365	26464	4
15	52652	60354	67983	75543	83033	90455	797810	05099	12323	19484	26582	5
30	52781	60481	68110	75668	83157	90578	797932	05220	12443	19602	26699	6
45	52910	60609	68237	75794	83281	90701	798054	05341	12563	19721	26817	7
2 0	53039	60737	68363	75919	83406	90824	798176	05461	12683	19840	26935	8
15	53168	60864	68490	76044	83530	90947	798298	05582	12802	19959	27053	9
30	53296	60992	68616	76170	83654	91070	798420	05703	12922	20078	27170	10
45	53425	61120	68743	76295	83778	91193	798542	05824	13042	20196	27288	11
3 0	53554	61247	68869	76420	83902	91316	798663	05945	13162	20315	27406	12
15	53683	61375	68995	76545	84026	91439	798785	06066	13281	20434	27523	13
30	53812	61503	69122	76671	84150	91562	798907	06186	13401	20552	27641	14
45	53941	61630	69248	76796	84275	91685	799029	06307	13521	20671	27759	15
4 0	54069	61758	69375	76921	84399	91808	799151	06428	13641	20790	27876	16
15	54198	61885	69501	77046	84523	91931	799273	06549	13760	20908	27994	17
30	54327	62013	69627	77172	84647	92054	799395	06669	13880	21027	28111	18
45	54455	62140	69754	77297	84771	92177	799516	06790	13999	21145	28229	19
5 0	54584	62268	69880	77422	84895	92300	799638	06911	14119	21264	28346	20
15	54713	62395	70006	77547	85019	92423	799760	07031	14239	21382	28464	21
30	54841	62523	70132	77672	85143	92545	799882	07152	14358	21501	28581	22
45	54970	62650	70259	77797	85266	92668	800003	07273	14478	21619	28699	23
6 0	55099	62777	70385	77922	85390	92791	800125	07393	14597	21738	28816	24
15	55227	62905	70511	78047	85514	92914	800247	07514	14717	21856	28934	25
30	55356	63032	70637	78172	85638	93037	800368	07635	14836	21975	29051	26
45	55484	63159	70763	78297	85762	93159	800490	07755	14956	22093	29169	27
7 0	55613	63287	70889	78422	85886	93282	800612	07876	15075	22212	29286	28
15	55741	63414	71016	78547	86010	93405	800733	07996	15195	22330	29403	29
30	55870	63541	71142	78672	86134	93527	800855	08117	15314	22449	29521	30
45	55998	63669	71268	78797	86257	93650	800976	08237	15434	22567	29638	31
8 0	56127	63796	71394	78922	86381	93773	801098	08358	15553	22685	29756	32
15	56255	63923	71520	79047	86505	93895	801219	08478	15672	22804	29873	33
30	56383	64050	71646	79172	86629	94018	801341	08598	15792	22922	29990	34
45	56512	64177	71772	79296	86752	94140	801462	08719	15911	23040	30107	35
9 0	56640	64305	71898	79421	86876	94263	801584	08839	16031	23159	30225	36
15	56768	64432	72024	79546	87000	94386	801705	08960	16150	23277	30342	37
30	56897	64559	72150	79671	87123	94508	801827	09080	16269	23395	30459	38
45	57025	64686	72276	79796	87247	94631	801948	09200	16388	23513	30576	39
10 0	57153	64813	72402	79920	87370	94753	802070	09321	16508	23632	30694	40
15	57282	64940	72527	80045	87494	94876	802191	09441	16627	23750	30811	41
30	57410	65067	72653	80170	87618	94998	802312	09561	16746	23868	30928	42
45	57538	65194	72779	80294	87741	95121	802434	09682	16865	23986	31045	43
11 0	57666	65321	72905	80419	87865	95243	802555	09802	16985	24104	31162	44
15	57794	65448	73031	80544	87988	95365	802676	09922	17104	24223	31279	45
30	57923	65575	73157	80668	88112	95488	802798	10042	17223	24341	31396	46
45	58051	65702	73282	80793	88235	95610	802919	10162	17342	24459	31513	47
12 0	58179	65829	73408	80918	88359	95733	803040	10283	17461	24577	31631	48
15	58307	65956	73534	81042	88482	95855	803161	10403	17580	24695	31748	49
30	58435	66083	73660	81167	88606	95977	803283	10523	17699	24813	31865	50
45	58563	66210	73785	81291	88729	96099	803404	10643	17818	24931	31982	51
13 0	58691	66336	73911	81416	88852	96222	803525	10763	17938	25049	32099	52
15	58819	66463	74037	81540	88976	96344	803646	10883	18057	25167	32216	53
30	58947	66590	74162	81665	89099	96466	803767	11003	18176	25285	32332	54
45	59075	66717	74288	81789	89222	96588	803888	11123	18295	25403	32449	55
14 0	59203	66844	74413	81914	89346	96711	804010	11243	18414	25521	32566	56
15	59331	66970	74539	82038	89469	96833	804131	11363	18533	25639	32683	57
30	59459	67097	74664	82163	89592	96955	804252	11483	18652	25757	32800	58
45	59587	67224	74790	82287	89716	97077	804373	11603	18770	25875	32917	59

	Sec.	1″	2″	3″	4″	5″	6″	7	8″	9″	10	11	12	13	14	15″
D. 129.	Parts	9	17	26	34	43	52	60	69	78	86	95	103	112	121	129
D. 117.	Parts	8	16	23	31	39	47	55	62	70	78	86	94	101	109	117

LOG. SINE SQUARE

	30°			31°				32°				33°	
	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	
	2h 1m	2h 2m	2h 3m	2h 4m	2h 5m	2h 6m	2h 7m	2h 8m	2h 9m	2h 10m	2h 11m	2h 12m	s.
′ ″	8·83	8·84	8·8	8·8	8·86	8·8	8·8	8·88	8·8	8·	8·90	8·9	
0 0	3034	0015	46936	53798	0602	67349	74040	0676	87258	893785	0261	06684	0
15	3151	0130	47050	53911	0715	67461	74151	0786	87367	893894	0368	06790	1
30	3268	0246	47165	54025	0828	67573	74262	0896	87476	894002	0476	06897	2
45	3384	0362	47280	54139	0941	67685	74373	1006	87585	894110	0583	07003	3
1 0	3501	0478	47395	54253	1053	67797	74484	1117	87694	894219	0690	07110	4
15	3618	0594	47510	54367	1166	67909	74595	1227	87804	894327	0798	07217	5
30	3735	0709	47624	54481	1279	68021	74706	1337	87913	894435	0905	07323	6
45	3851	0825	47739	54594	1392	68133	74817	1447	88022	894544	1013	07430	7
2 0	3968	0941	47854	54708	1505	68245	74928	1557	88131	894652	1120	07536	8
15	4085	1056	47968	54822	1618	68356	75039	1667	88240	894760	1227	07643	9
30	4201	1172	48083	54936	1730	68468	75150	1777	88349	894868	1335	07749	10
45	4318	1288	48198	55049	1843	68580	75261	1887	88458	894976	1442	07856	11
3 0	4435	1404	48313	55163	1956	68692	75372	1997	88567	895085	1549	07962	12
15	4551	1519	48427	55277	2069	68804	75483	2107	88676	895193	1657	08068	13
30	4668	1635	48542	55390	2181	68915	75594	2217	88786	895301	1764	08175	14
45	4785	1750	48657	55504	2294	69027	75704	2327	88895	895409	1871	08281	15
4 0	4901	1866	48771	55618	2407	69139	75815	2436	89004	895517	1978	08388	16
15	5018	1982	48886	55731	2519	69251	75926	2546	89113	895625	2086	08494	17
30	5134	2097	49000	55845	2632	69362	76037	2656	89222	895734	2193	08600	18
45	5251	2213	49115	55959	2745	69474	76148	2766	89330	895842	2300	08707	19
5 0	5367	2328	49229	56072	2857	69586	76258	2876	89439	895950	2407	08813	20
15	5484	2444	49344	56186	2970	69697	76369	2986	89548	896058	2514	08919	21
30	5600	2559	49458	56299	3082	69809	76480	3096	89657	896166	2622	09026	22
45	5717	2675	49573	56413	3195	69921	76590	3205	89766	896274	2729	09132	23
6 0	5833	2790	49687	56526	3308	70032	76701	3315	89875	896382	2836	09238	24
15	5950	2905	49802	56640	3420	70144	76812	3425	89984	896490	2943	09345	25
30	6066	3021	49916	56753	3533	70255	76923	3535	90093	896598	3050	09451	26
45	6183	3136	50031	56867	3645	70367	77033	3644	90202	896706	3157	09557	27
7 0	6299	3251	50145	56980	3758	70479	77144	3754	90311	896814	3264	09663	28
15	6415	3367	50259	57094	3870	70590	77254	3864	90419	896922	3371	09770	29
30	6532	3482	50374	57207	3983	70702	77365	3974	90528	897030	3479	09876	30
45	6648	3598	50488	57320	4095	70813	77476	4083	90637	897137	3586	09982	31
8 0	6764	3713	50603	57434	4207	70925	77586	4193	90746	897245	3693	10088	32
15	6881	3828	50717	57547	4320	71036	77697	4303	90854	897353	3800	10194	33
30	6997	3944	50831	57660	4432	71148	77807	4412	90963	897461	3907	10301	34
45	7113	4059	50945	57774	4545	71259	77918	4522	91072	897569	4014	10407	35
9 0	7230	4174	51060	57887	4657	71370	78028	4632	91181	897677	4121	10513	36
15	7346	4289	51174	58000	4769	71482	78139	4741	91289	897785	4228	10619	37
30	7462	4405	51288	58114	4882	71593	78249	4851	91398	897892	4334	10725	38
45	7578	4520	51403	58227	4994	71705	78360	4960	91507	898000	4441	10831	39
10 0	7694	4635	51517	58340	5106	71816	78470	5070	91615	898108	4548	10937	40
15	7811	4750	51631	58453	5219	71927	78581	5179	91724	898216	4655	11043	41
30	7927	4865	51745	58567	5331	72039	78691	5289	91833	898324	4762	11149	42
45	8043	4981	51859	58680	5443	72150	78802	5398	91941	898431	4869	11255	43
11 0	8159	5096	51973	58793	5555	72261	78912	5508	92050	898539	4976	11361	44
15	8275	5211	52088	58906	5668	72373	79022	5617	92158	898647	5083	11467	45
30	8391	5326	52202	59019	5780	72484	79133	5727	92267	898754	5190	11573	46
45	8507	5441	52316	59132	5892	72595	79243	5836	92376	898862	5296	11679	47
12 0	8623	5556	52430	59246	6004	72706	79353	5946	92484	898970	5403	11785	48
15	8739	5671	52544	59359	6116	72818	79464	6055	92593	899077	5510	11891	49
30	8855	5786	52658	59472	6229	72929	79574	6164	92701	899185	5617	11997	50
45	8971	5901	52772	59585	6341	73040	79684	6274	92810	899293	5723	12103	51
13 0	9087	6016	52886	59698	6453	73151	79795	6383	92918	899400	5830	12209	52
15	9203	6131	53000	59811	6565	73262	79905	6492	93027	899508	5937	12315	53
30	9319	6246	53114	59924	6677	73374	80015	6602	93135	899615	6044	12421	54
45	9435	6361	53228	60037	6789	73485	80125	6711	93244	899723	6150	12526	55
14 0	9551	6476	53342	60150	6901	73596	80235	6821	93352	899831	6257	12632	56
15	9667	6591	53456	60263	7013	73707	80346	6930	93460	899938	6364	12738	57
30	9783	6706	53570	60376	7125	73818	80456	7039	93569	900046	6470	12844	58
45	9899	6821	53684	60489	7237	73929	80566	7148	93677	900153	6577	12950	59

	Sec.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
D. 116.	Parts	8	15	23	31	39	46	54	62	68	77	85	93	100	108	116
D. 106.	Parts	7	14	21	29	36	43	49	56	63	71	78	85	92	99	106

LOG. SINE SQUARE

	33°			34°				35°				
	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	
	2h 13m	2h 14m	2h 15m	2h 16m	2h 17m	2h 18m	2h 19m	2h 20m	2h 21m	2h 22m	2h 23m	s.
′ ″	8·9	8·9	8·9	8·9	8·9	8·9	8·9	8·9	8·9	8·9	8·9	
0 0	13055	19377	25648	31871	38045	44171	50251	56284	62271	68213	74111	0
15	13161	19482	25752	31974	38147	44273	50351	56384	62370	68312	74209	1
30	13267	19587	25856	32077	38250	44375	50452	56484	62470	68410	74307	2
45	13373	19691	25960	32181	38352	44476	50553	56584	62569	68509	74405	3
1 0	13478	19796	26065	32284	38455	44578	50654	56684	62668	68608	74502	4
15	13584	19901	26169	32387	38557	44680	50755	56784	62768	68706	74600	5
30	13690	20006	26273	32490	38660	44781	50856	56884	62867	68805	74698	6
45	13795	20111	26377	32593	38762	44883	50957	56984	62966	68903	74796	7
2 0	13901	20216	26481	32697	38864	44984	51058	57085	63066	69002	74894	8
15	14007	20321	26585	32800	38967	45086	51158	57185	63165	69101	74992	9
30	14112	20425	26689	32903	39069	45188	51259	57285	63264	69199	75090	10
45	14218	20530	26793	33006	39171	45289	51360	57385	63364	69298	75187	11
3 0	14324	20635	26897	33109	39274	45391	51461	57485	63463	69396	75285	12
15	14429	20740	27000	33212	39376	45492	51562	57585	63562	69495	75383	13
30	14535	20844	27104	33316	39479	45594	51662	57685	63661	69593	75481	14
45	14640	20949	27208	33419	39581	45695	51763	57785	63761	69692	75578	15
4 0	14746	21054	27312	33522	39683	45797	51864	57885	63860	69790	75676	16
15	14852	21159	27416	33625	39785	45898	51965	57985	63959	69889	75774	17
30	14957	21263	27520	33728	39888	46000	52065	58085	64058	69987	75872	18
45	15063	21368	27624	33831	39990	46101	52166	58185	64157	70086	75969	19
5 0	15168	21473	27728	33934	40092	46203	52267	58284	64257	70184	76067	20
15	15274	21577	27832	34037	40194	46304	52367	58384	64356	70282	76165	21
30	15379	21682	27935	34140	40297	46406	52468	58484	64455	70381	76262	22
45	15484	21787	28039	34243	40399	46507	52569	58584	64554	70479	76360	23
6 0	15590	21891	28143	34346	40501	46609	52669	58684	64653	70578	76458	24
15	15695	21996	28247	34449	40603	46710	52770	58784	64752	70676	76555	25
30	15801	22100	28351	34552	40705	46811	52871	58884	64851	70774	76653	26
45	15906	22205	28454	34655	40807	46915	52971	58984	64950	70873	76750	27
7 0	16012	22310	28558	34758	40910	47014	53072	59083	65050	70971	76848	28
15	16117	22414	28662	34861	41012	47115	53172	59183	65149	71069	76946	29
30	16222	22519	28766	34964	41114	47217	53273	59283	65248	71168	77043	30
45	16328	22623	28869	35067	41216	47318	53373	59383	65347	71266	77141	31
8 0	16433	22728	28973	35170	41318	47419	53474	59482	65446	71364	77238	32
15	16538	22832	29077	35272	41420	47521	53574	59582	65545	71462	77336	33
30	16644	22937	29180	35375	41522	47622	53675	59682	65644	71561	77433	34
45	16749	23041	29284	35478	41624	47723	53775	59782	65743	71659	77531	35
9 0	16854	23146	29388	35581	41726	47824	53876	59881	65842	71757	77628	36
15	16959	23250	29491	35684	41828	47926	53976	59981	65941	71855	77726	37
30	17065	23354	29595	35787	41930	48027	54077	60081	66040	71953	77823	38
45	17170	23459	29698	35889	42032	48128	54177	60180	66138	72052	77921	39
10 0	17275	23563	29802	35992	42134	48229	54278	60280	66237	72150	78018	40
15	17380	23668	29905	36095	42236	48330	54378	60380	66336	72248	78116	41
30	17486	23772	30009	36198	42338	48432	54479	60479	66435	72346	78213	42
45	17591	23876	30113	36300	42440	48533	54579	60579	66534	72444	78311	43
11 0	17696	23981	30216	36403	42542	48634	54679	60679	66633	72542	78408	44
15	17801	24085	30320	36506	42644	48735	54780	60778	66732	72641	78505	45
30	17906	24189	30423	36608	42746	48836	54880	60878	66831	72739	78603	46
45	18011	24294	30527	36711	42848	48937	54980	60977	66929	72837	78700	47
12 0	18116	24398	30630	36814	42950	49038	55081	61077	67028	72935	78797	48
15	18221	24502	30734	36916	43052	49139	55181	61177	67127	73033	78895	49
30	18327	24606	30837	37019	43153	49241	55281	61276	67226	73131	78992	50
45	18432	24711	30940	37122	43255	49342	55382	61376	67325	73229	79089	51
13 0	18537	24815	31044	37224	43357	49443	55482	61475	67423	73327	79187	52
15	18642	24919	31147	37327	43459	49544	55582	61575	67522	73425	79284	53
30	18747	25023	31251	37430	43561	49645	55682	61674	67621	73523	79381	54
45	18852	25127	31354	37532	43662	49746	55783	61774	67720	73621	79479	55
14 0	18957	25232	31457	37635	43764	49847	55883	61873	67818	73719	79576	56
15	19062	25336	31561	37737	43866	49948	55983	61973	67917	73817	79673	57
30	19167	25440	31664	37840	43968	50049	56083	62072	68016	73915	79770	58
45	19272	25544	31767	37942	44069	50150	56183	62171	68114	74013	79868	59

	Sec.	1″	2″	3	4	5″	6	7″	8	9	10	11″	12	13″	14	15″
D. 105.	Parts	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105
D. 97.	Parts	6	13	19	26	32	39	45	52	58	65	71	78	84	91	97

LOG. SINE SQUARE

		36°				37°				38°			
		0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	
		$2^h 24^m$	$2^h 25^m$	$2^h 26^m$	$2^h 27^m$	$2^h 28^m$	$2^h 29^m$	$2^h 30^m$	$2^h 31^m$	$2^h 32^m$	$2^h 33^m$	$2^h 34^m$	s.
′	″	8·9	8·9	8·9		9·0	9·0	9·0	9·0	9·0	9·0	9·0	
0	0	79965	85775	91543	8·997269	02953	08596	14198	19761	25284	30768	36213	0
	15	80062	85872	91639	8·997364	03047	08690	14291	19853	25375	30859	36304	1
	30	80159	85968	91735	8·997459	03142	08783	14384	19946	25467	30950	36394	2
	45	80256	86065	91830	8·997554	03236	08877	14477	20038	25559	31041	36485	3
1	0	80353	86161	91926	8·997649	03330	08971	14570	20130	25651	31132	36575	4
	15	80451	86258	92022	8·997744	03425	09064	14663	20223	25742	31223	36665	5
	30	80548	86354	92118	8·997839	03519	09158	14757	20315	25834	31314	36756	6
	45	80645	86450	92213	8·997934	03613	09252	14849	20407	25926	31405	36846	7
2	0	80742	86547	92309	8·998029	03708	09345	14942	20500	26017	31496	36936	8
	15	80839	86643	92405	8·998124	03802	09439	15035	20592	26109	31587	37027	9
	30	80936	86740	92500	8·998219	03896	09532	15128	20684	26201	31678	37117	10
	45	81033	86836	92596	8·998314	03990	09626	15221	20776	26292	31769	37207	11
3	0	81130	86932	92692	8·998409	04085	09720	15314	20869	26384	31860	37298	12
	15	81227	87029	92787	8·998504	04179	09813	15407	20961	26475	31951	37388	13
	30	81324	87125	92883	8·998599	04273	09907	15500	21053	26567	32042	37478	14
	45	81421	87221	92978	8·998694	04367	10000	15593	21145	26658	32133	37569	15
4	0	81518	87318	93074	8·998789	04462	10094	15686	21237	26750	32224	37659	16
	15	81615	87414	93170	8·998883	04556	10187	15778	21330	26842	32315	37749	17
	30	81712	87510	93265	8·998978	04650	10281	15871	21422	26933	32405	37839	18
	45	81809	87606	93361	8·999073	04744	10374	15964	21514	27025	32496	37930	19
5	0	81906	87703	93456	8·999168	04838	10468	16057	21606	27116	32587	38020	20
	15	82003	87799	93552	8·999263	04933	10561	16150	21698	27208	32678	38110	21
	30	82100	87895	93647	8·999358	05027	10654	16243	21791	27299	32769	38200	22
	45	82197	87991	93743	8·999453	05121	10748	16335	21883	27391	32860	38291	23
6	0	82294	88088	93838	8·999547	05215	10842	16428	21975	27482	32951	38381	24
	15	82391	88184	93934	8·999642	05309	10935	16521	22067	27574	33041	38471	25
	30	82488	88280	94029	8·999737	05403	11029	16614	22159	27665	33132	38561	26
	45	82585	88376	94125	8·999832	05497	11122	16706	22251	27756	33223	38651	27
7	0	82682	88472	94220	8·999927	05591	11215	16799	22343	27848	33314	38741	28
	15	82779	88568	94316	9·000021	05685	11309	16893	22435	27939	33405	38832	29
	30	82875	88665	94411	9·000116	05780	11402	16985	22527	28031	33495	38922	30
	45	82972	88761	94507	9·000211	05874	11496	17077	22619	28122	33586	39012	31
8	0	83069	88857	94602	9·000305	05968	11589	17170	22711	28213	33677	39102	32
	15	83166	88953	94697	9·000400	06062	11682	17263	22803	28305	33768	39192	33
	30	83263	89049	94793	9·000495	06156	11776	17355	22895	28396	33858	39282	34
	45	83359	89145	94888	9·000590	06250	11869	17448	22987	28488	33949	39372	35
9	0	83456	89241	94984	9·000684	06344	11962	17541	23079	28579	34040	39462	36
	15	83553	89337	95079	9·000779	06438	12055	17633	23171	28670	34130	39552	37
	30	83650	89433	95174	9·000874	06532	12149	17726	23263	28762	34221	39642	38
	45	83746	89529	95269	9·000968	06625	12242	17819	23355	28853	34312	39732	39
10	0	83843	89625	95365	9·001063	06719	12335	17911	23447	28944	34402	39822	40
	15	83940	89721	95460	9·001157	06813	12429	18004	23539	29035	34493	39912	41
	30	84037	89817	95555	9·001252	06907	12522	18096	23631	29127	34584	40002	42
	45	84133	89913	95651	9·001347	07001	12615	18189	23723	29218	34674	40092	43
11	0	84230	90009	95746	9·001441	07095	12708	18281	23815	29309	34765	40182	44
	15	84327	90105	95841	9·001536	07189	12802	18374	23907	29400	34855	40272	45
	30	84423	90201	95937	9·001630	07283	12895	18467	23999	29492	34946	40362	46
	45	84520	90297	96032	9·001725	07377	12988	18559	24091	29583	35037	40452	47
12	0	84617	90393	96127	9·001819	07471	13081	18652	24182	29674	35127	40542	48
	15	84713	90489	96222	9·001914	07564	13174	18744	24274	29765	35218	40632	49
	30	84810	90585	96317	9·002008	07658	13267	18837	24366	29856	35308	40722	50
	45	84906	90681	96413	9·002103	07752	13361	18929	24458	29948	35399	40812	51
13	0	85003	90777	96508	9·002197	07846	13454	19021	24550	30039	35489	40902	52
	15	85100	90872	96603	9·002292	07940	13547	19114	24642	30130	35580	40992	53
	30	85196	90968	96698	9·002386	08033	13640	19206	24733	30221	35670	41082	54
	45	85293	91064	96793	9·002481	08127	13733	19299	24825	30312	35761	41171	55
14	0	85389	91160	96888	9·002575	08221	13826	19391	24917	30403	35851	41261	56
	15	85486	91256	96983	9·002670	08315	13919	19484	25009	30495	35942	41351	57
	30	85582	91352	97079	9·002764	08408	14012	19576	25100	30586	36032	41441	58
	45	85679	91447	97174	9·002858	08502	14105	19668	25192	30677	36123	41531	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 97.	Parts	6	13	19	26	32	39	45	52	58	65	71	78	84	91	97
D. 90.	Parts	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90

LOG. SINE SQUARE

	38°	39°				40°				41°		
	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	
	2h 35m	2h 36m	2h 37m	2h 38m	2h 39m	2h 40m	2h 41m	2h 42m	2h 43m	2h 44m	2h 45m	s.
′ ″	9·0	9·0	9·0	9·0	9·0	9·0	9·0	9·0	9·0	9·0	9·0	
0 0	41621	46991	52323	57619	62879	68103	73292	78446	83565	88651	93702	0
15	41710	47080	52412	57707	62967	68190	73378	78532	83650	88735	93786	1
30	41800	47169	52500	57795	63054	58277	73465	78617	83735	88819	93870	2
45	41890	47258	52589	57883	63141	68364	73551	78703	83820	88904	93954	3
1 0	41980	47347	52677	57971	63229	68450	73637	78788	83905	88988	94038	4
15	42070	47436	52766	58059	63316	68537	73723	78874	83990	89073	94122	5
30	42159	47525	52855	58147	63403	68624	73809	78960	84075	89157	94205	6
45	42249	47615	52943	58235	63491	68710	73895	79045	84160	89242	94289	7
2 0	42339	47704	53032	58323	63578	68797	73981	79131	84245	89326	94373	8
15	42428	47793	53120	58411	63665	68884	74067	79216	84330	89410	94457	9
30	42518	47882	53208	58499	63752	68971	74154	79302	84415	89495	94541	10
45	42608	47971	53297	58586	63840	69057	74240	79387	84500	89579	94625	11
3 0	42698	48060	53385	58674	63927	69144	74326	79473	84585	89664	94708	12
15	42787	48149	53474	58762	64014	69231	74412	79558	84670	89748	94792	13
30	42877	48238	53562	58850	64101	69317	74498	79644	84755	89832	94876	14
45	42967	48327	53651	58938	64189	69404	74584	79729	84840	89917	94960	15
4 0	43056	48416	53739	59025	64276	69490	74670	79815	84925	90001	95044	16
15	43146	48505	53828	59113	64363	69577	74756	79900	85010	90085	95127	17
30	43236	48594	53916	59201	64450	69664	74842	79985	85094	90170	95211	18
45	43325	48683	54004	59289	64537	69750	74928	80071	85179	90254	95295	19
5 0	43415	48772	54093	59377	64625	69837	75014	80156	85264	90338	95379	20
15	43504	48861	54181	59464	64712	69923	75100	80242	85349	90422	95462	21
30	43594	48950	54269	59552	64799	70010	75186	80327	85434	90507	95546	22
45	43684	49039	54358	59640	64886	70107	75272	80412	85519	90591	95630	23
6 0	43773	49128	54446	59728	64973	70183	75358	80498	85603	90675	95713	24
15	43863	49217	54534	59815	65060	70270	75444	80583	85688	90759	95797	25
30	43952	49306	54623	59903	65147	70356	75530	80669	85773	90844	95881	26
45	44042	49395	54711	59991	65234	70443	75616	80754	85858	90928	95964	27
7 0	44131	49484	54799	60079	65322	70529	75702	80839	85943	91012	96048	28
15	44221	49573	54888	60166	65409	70616	75787	80925	86027	91096	96132	29
30	44310	49662	54976	60254	65496	70702	75873	81010	86112	91181	96215	30
45	44400	49750	55064	60341	65583	70789	75959	81095	86197	91265	96299	31
8 0	44489	49839	55152	60429	65670	70875	76045	81181	86282	91349	96383	32
15	44579	49928	55241	60517	65757	70961	76131	81266	86366	91433	96466	33
30	44668	50017	55329	60604	65844	71048	76217	81351	86451	91517	96550	34
45	44758	50106	55417	60692	65931	71134	76303	81436	86536	91601	96633	35
9 0	44847	50195	55505	60780	66018	71221	76389	81522	86621	91685	96717	36
15	44936	50283	55593	60867	66105	71307	76474	81607	86705	91770	96801	37
30	45026	50372	55682	60955	66192	71394	76560	81692	86790	91854	96884	38
45	45115	50461	55770	61042	66279	71480	76646	81778	86875	91938	96968	39
10 0	45205	50550	55858	61130	66366	71566	76732	81863	86959	92022	97051	40
15	45294	50639	55946	61218	66453	71653	76818	81948	87044	92106	97135	41
30	45383	50727	56034	61305	66540	71739	76903	82033	87128	92190	97218	42
45	45473	50816	56122	61393	66627	71826	76989	82118	87213	92274	97302	43
11 0	45562	50905	56211	61480	66714	71912	77075	82203	87298	92358	97385	44
15	45652	50994	56299	61568	66801	71998	77161	82289	87382	92442	97469	45
30	45741	51082	56387	61655	66888	72085	77247	82374	87467	92526	97552	46
45	45830	51171	56475	61743	66974	72171	77332	82459	87552	92610	97636	47
12 0	45920	51260	56563	61830	67061	72257	77418	82544	87636	92694	97719	48
15	46009	51348	56651	61918	67148	72343	77504	82629	87721	92778	97803	49
30	46098	51437	56739	62015	67235	72430	77589	82714	87805	92862	97886	50
45	46187	51526	56827	62093	67322	72516	77675	82800	87890	92946	97970	51
13 0	46277	51614	56915	62180	67409	72602	77761	82885	87975	93030	98053	52
15	46366	51703	57003	62267	67496	72689	77846	82970	88059	93114	98137	53
30	46455	51792	57091	62355	67583	72775	77932	83055	88144	93198	98220	54
45	46544	51880	57179	62442	67669	72861	78018	83140	88228	93282	98303	55
14 0	46634	51969	57267	62530	67756	72947	78103	83225	88313	93366	98387	56
15	46723	52057	57355	62617	67843	73034	78189	83310	88397	93450	98470	57
30	46812	52146	57443	62704	67930	73120	78275	83395	88482	93534	98554	58
45	46901	52235	57531	62792	68017	73206	78360	83480	88566	93618	98637	59

		1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
	Sec.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
D 90.	Parts	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90
D 84.	Parts	6	11	17	22	28	34	39	45	50	56	62	67	73	78	84

LOG. SINE SQUARE

	41°		42°				43°				44°	
	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	
′ ″	2h 46m	2h 47m	2h 48m	2h 49m	2h 50m	2h 51m	2h 52m	2h 53m	2h 54m	2h 55m	2h 56m	s
	9·	9·1	9·1	9·1	9·1	9·1	9·1	9·1	9·1	9·1	9·1	
0 0	098720	03706	08658	13579	18468	23325	28151	32946	37711	42446	47151	0
15	098804	03788	08741	13661	18549	23405	28231	33026	37790	42524	47229	1
30	098887	03871	08823	13742	18630	23486	28311	33105	37869	42603	47307	2
45	098970	03954	08905	13824	18711	23567	28391	33185	37948	42682	47385	3
1 0	099054	04037	08987	13906	18792	23647	28471	33265	38028	42760	47463	4
15	099137	04120	09070	13987	18873	23728	28552	33344	38107	42839	47542	5
30	099220	04202	09152	14069	18955	23809	28632	33424	38186	42918	47620	6
45	099304	04285	09234	14151	19036	23889	28712	33504	38265	42996	47698	7
2 0	099387	04368	09316	14232	19117	23970	28792	33583	38344	43075	47776	8
15	099470	04451	09398	14314	19198	24051	28872	33663	38423	43153	47854	9
30	099553	04533	09481	14396	19279	24131	28952	33742	38502	43232	47932	10
45	099637	04616	09563	14477	19360	24212	29032	33822	38581	43311	48010	11
3 0	099720	04699	09645	14559	19441	24292	29112	33902	38660	43389	48088	12
15	099803	04781	09727	14641	19523	24373	29192	33981	38739	43468	48166	13
30	099886	04864	09809	14722	19604	24454	29272	34061	38819	43546	48244	14
45	099970	04947	09891	14804	19685	24534	29353	34140	38898	43625	48322	15
4 0	100053	05030	09974	14886	19766	24615	29433	34220	38977	43703	48401	16
15	100136	05112	10055	14967	19847	24695	29513	34299	39056	43782	48479	17
30	100219	05195	10138	15049	19928	24776	29593	34379	39135	43860	48557	18
45	100303	05277	10220	15130	20009	24856	29673	34458	39214	43939	48635	19
5 0	100386	05360	10302	15212	20090	24937	29753	34538	39293	44018	48713	20
15	100469	05443	10384	15293	20171	25017	29833	34617	39372	44096	48791	21
30	100552	05525	10466	15375	20252	25098	29913	34697	39451	44174	48869	22
45	100635	05608	10548	15457	20333	25178	29993	34776	39530	44253	48947	23
6 0	100718	05691	10630	15538	20414	25259	30073	34856	39609	44331	49025	24
15	100801	05773	10712	15620	20495	25339	30153	34935	39688	44410	49102	25
30	100885	05856	10794	15701	20576	25420	30233	35015	39766	44488	49180	26
45	100968	05938	10877	15783	20657	25500	30313	35094	39845	44567	49258	27
7 0	101051	06021	10959	15864	20738	25581	30393	35174	39924	44645	49336	28
15	101134	06103	11041	15946	20819	25661	30472	35253	40003	44724	49414	29
30	101217	06186	11123	16027	20900	25742	30552	35332	40082	44802	49492	30
45	101300	06269	11205	16109	20981	25822	30632	35412	40161	44880	49570	31
8 0	101383	06351	11287	16190	21062	25902	30712	35491	40240	44959	49648	32
15	101466	06434	11369	16272	21143	25983	30792	35571	40319	45037	49726	33
30	101549	06516	11451	16353	21224	26063	30872	35650	40398	45116	49804	34
45	101632	06599	11533	16434	21305	26144	30952	35729	40477	45194	49882	35
9 0	101715	06681	11614	16516	21385	26224	31032	35809	40556	45272	49960	36
15	101798	06764	11696	16597	21466	26305	31112	35888	40634	45351	50038	37
30	101881	06846	11778	16679	21547	26385	31191	35967	40713	45429	50115	38
45	101964	06929	11860	16760	21628	26465	31271	36047	40792	45507	50193	39
10 0	102047	07011	11942	16841	21709	26546	31351	36126	40871	45586	50271	40
15	102130	07093	12024	16923	21790	26626	31431	36205	40950	45664	50349	41
30	102213	07176	12106	17004	21871	26706	31511	36285	41029	45742	50427	42
45	102296	07258	12188	17086	21952	26787	31591	36364	41107	45821	50505	43
11 0	102379	07341	12270	17167	22033	26867	31670	36443	41186	45899	50582	44
15	102462	07423	12352	17248	22113	26947	31750	36523	41265	45977	50660	45
30	102545	07506	12434	17330	22194	27028	31830	36602	41344	46056	50738	46
45	102628	07588	12515	17411	22275	27108	31910	36681	41423	46134	50816	47
12 0	102711	07670	12597	17492	22356	27188	31990	36761	41501	46212	50894	48
15	102794	07753	12679	17574	22437	27268	32069	36840	41580	46290	50971	49
30	102877	07835	12761	17655	22517	27349	32149	36919	41659	46369	51049	50
45	102960	07917	12843	17736	22598	27429	32229	36998	41738	46447	51127	51
13 0	103043	08000	12925	17818	22679	27509	32309	37077	41816	46525	51205	52
15	103126	08082	13006	17899	22759	27589	32388	37157	41895	46603	51282	53
30	103209	08164	13088	17980	22840	27670	32468	37236	41974	46682	51360	54
45	103291	08247	13170	18061	22921	27750	32548	37315	42052	46760	51438	55
14 0	103374	08329	13252	18143	23002	27830	32627	37394	42131	46838	51516	56
15	103457	08411	13334	18224	23083	27910	32707	37474	42210	46916	51593	57
30	103540	08494	13415	18305	23163	27990	32787	37553	42288	46994	51671	58
45	103623	08576	13497	18386	23244	28071	32867	37632	42367	47073	51749	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 83.	Parts	5	11	16	22	28	33	39	44	50	55	61	66	72	77	83
D. 78.	Parts	5	10	16	21	26	31	36	42	47	52	57	62	68	73	78

LOG. SINE SQUARE

	44°			45°				46°				47°	
	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	
	2h 57m	2h 58m	2h 59m	3h 0m	3h 1m	3h 2m	3h 3m	3h 4m	3h 5m	3h 6m	3h 7m	3h 8m	s.
′ ″	9·1	9·1	9·1	9·1	9·17	9·17	9·1	9·18	9·1	9·19	9·	9·20	
0 0	51826	56473	61090	65679	0240	4773	79278	3756	88207	2631	197028	1399	0
15	51904	56550	61167	65756	0316	4848	79353	3830	88281	2704	197101	1472	1
30	51982	56627	61244	65832	0392	4924	79428	3905	88355	2778	197174	1545	2
45	52059	56704	61320	65908	0467	4999	79503	3979	88429	2851	197247	1617	3
1 0	52137	56781	61397	65984	0543	5074	79578	4054	88503	2925	197320	1690	4
15	52215	56859	61474	66060	0619	5149	79652	4128	88576	2998	197393	1762	5
30	52292	56936	61550	66137	0695	5225	79727	4202	88650	3072	197466	1835	6
45	52370	57013	61627	66213	0770	5300	79802	4277	88724	3145	197539	1908	7
2 0	52448	57090	61704	66289	0846	5375	79877	4351	88798	3219	197613	1980	8
15	52525	57167	62780	66365	0922	5450	79952	4425	88872	3292	197686	2053	9
30	52603	57244	61857	66441	0998	5526	80026	4500	88946	3366	197759	2125	10
45	52680	57321	61934	66518	1073	5601	80101	4574	89020	3439	197832	2198	11
3 0	52758	57399	62010	66594	1149	5676	80176	4648	89094	3512	197905	2270	12
15	52836	57476	62087	66670	1225	5751	80251	4723	89168	3586	197977	2343	13
30	52913	57553	62164	66746	1300	5827	80325	4797	89241	3659	198050	2416	14
45	52991	57630	62240	66822	1376	5902	80400	4871	89315	3733	198123	2488	15
4 0	53068	57707	62317	66898	1452	5977	80475	4946	89389	3806	198196	2561	16
15	53146	57784	62393	66974	1527	6052	80550	5020	89463	3879	198269	2633	17
30	53233	57861	62470	67051	1603	6127	80624	5094	89537	3953	198342	2706	18
45	53301	57938	62547	67127	1679	6203	80699	5168	89611	4026	198415	2778	19
5 0	53378	58015	62623	67203	1754	6278	80774	5243	89684	4100	198488	2851	20
15	53456	58092	62700	67279	1830	6353	80849	5317	89758	4173	198561	2923	21
30	53533	58169	62776	67355	1905	6428	80923	5391	89832	4246	198634	2996	22
45	53611	58246	62853	67431	1981	6503	80998	5465	89906	4320	198707	3068	23
6 0	53688	58323	62929	67507	2057	6578	81073	5540	89980	4393	198780	3141	24
15	53766	58400	63006	67583	2132	6653	81147	5614	90053	4466	198853	3213	25
30	53843	58477	63082	67659	2208	6729	81222	5688	90127	4540	198926	3285	26
45	53921	58554	63159	67735	2283	6804	81297	5762	90201	4613	198998	3358	27
7 0	53998	58631	63235	67811	2359	6879	81371	5836	90275	4686	199071	3430	28
15	54076	58708	63312	67887	2435	6954	81446	5911	90348	4759	199144	3503	29
30	54153	58785	63388	67963	2510	7029	81521	5985	90422	4833	199217	3575	30
45	54231	58862	63465	68039	2586	7104	81595	6059	90496	4906	199290	3648	31
8 0	54308	58939	63541	68115	2661	7179	81670	6133	90570	4979	199363	3720	32
15	54385	59016	63618	68191	2737	7254	81744	6207	90643	5053	199436	3792	33
30	54463	59093	63694	68267	2812	7329	81819	6281	90717	5126	199508	3865	34
45	54540	59170	63771	68343	2888	7404	81894	6356	90791	5199	199581	3937	35
9 0	54618	59247	63847	68419	2963	7479	81968	6430	90864	5272	199654	4010	36
15	54695	59324	63924	68495	3039	7554	82043	6504	90938	5346	199727	4082	37
30	54772	59401	64000	68571	3114	7629	82117	6578	91012	5419	199800	4154	38
45	54850	59477	64076	68647	3190	7704	82192	6652	91085	5492	199872	4227	39
10 0	54927	59554	64153	68723	3265	7779	82266	6726	91159	5565	199945	4299	40
15	55005	59631	64229	68799	3341	7854	82341	6800	91233	5639	200018	4371	41
30	55082	59708	64306	68875	3416	7929	82416	6874	91306	5712	200091	4444	42
45	55159	59785	64382	68951	3491	8004	82490	6948	91380	5785	200164	4516	43
11 0	55237	59862	64458	69027	3567	8079	82565	7023	91454	5858	200236	4588	44
15	55314	59939	64535	69103	3642	8154	82639	7097	91527	5931	200309	4661	45
30	55391	60015	64611	69178	3718	8229	82714	7171	91601	6004	200382	4733	46
45	55468	60092	64687	69254	3793	8304	82788	7245	91674	6078	200455	4805	47
12 0	55546	60169	64764	69330	3869	8379	82863	7319	91748	6151	200527	4878	48
15	55623	60246	64840	69406	3944	8454	82937	7393	91822	6224	200600	4950	49
30	55700	60323	64916	69482	4019	8529	83012	7467	91895	6297	200673	5022	50
45	55778	60399	64993	69558	4095	8604	83086	7541	91969	6370	200745	5094	51
13 0	55855	60476	65069	69634	4170	8679	83161	7615	92042	6443	200818	5167	52
15	55932	60553	65145	69709	4246	8754	83235	7689	92116	6517	200891	5239	53
30	56009	60630	65222	69785	4321	8829	83309	7763	92190	6590	200963	5311	54
45	56087	60707	65298	69861	4396	8904	83384	7837	92263	6663	201036	5383	55
14 0	56164	60783	65374	69937	4472	8979	83458	7911	92337	6736	201109	5456	56
15	56241	60860	65450	70013	4547	9054	83533	7985	92410	6809	201181	5528	57
30	56318	60937	65527	70089	4622	9128	83607	8059	92484	6882	201254	5600	58
45	56396	61014	65503	70164	4698	9203	83682	8133	92557	6955	201327	5672	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 78.	Parts	5	10	16	21	26	31	36	42	47	52	57	62	68	73	78
D. 72.	Parts	5	10	14	19	24	29	34	38	43	48	53	58	62	67	72

LOG. SINE SQUARE

	47°			48°				49°				
	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	
m s	3h 9m	3h 10m	3h 11m	3h 12m	3h 13m	3h 14m	3h 15m	3h 16m	3h 17m	3h 18m	3h 19m	s.
	9·2	9·2	9·2	9·2	9·2	9·2	9·2	9·2	9·2	9·2	9·2	
0 0	05745	10064	14358	18627	22870	27089	31284	35454	39600	43722	47821	0
15	05817	10136	14429	18698	22941	27159	31353	35523	39669	43791	47889	1
30	05889	10207	14501	18768	23011	27229	31423	35593	39738	43859	47957	2
45	05961	10279	14572	18839	23082	27300	31493	35662	39807	43928	48025	3
1 0	06033	10351	14643	18910	23152	27370	31502	35731	39876	43996	48094	4
15	06105	10423	14715	18981	23223	27440	31632	35800	39944	44065	48162	5
30	06178	10494	14786	19052	23293	27510	31702	35870	40013	44133	48230	6
45	06250	10566	14857	19123	23364	27580	31772	35939	40082	44202	48298	7
2 0	06322	10638	14929	19194	23434	27650	31841	36008	40151	44270	48366	8
15	06394	10710	15000	19265	23505	27720	31911	36077	40220	44339	48434	9
30	06466	10781	15071	19336	23575	27790	31980	36147	40289	44407	48502	10
45	06538	10853	15142	19406	23646	27860	32050	36216	40358	44476	48570	11
3 0	06610	10925	15214	19477	23716	27930	32120	36285	40426	44544	48638	12
15	06682	10996	15285	19548	23786	28000	32189	36354	40495	44612	48706	13
30	06755	11068	15356	19619	23857	28070	32259	36423	40564	44681	48774	14
45	06827	11140	15427	19690	23927	28140	32329	36493	40633	44749	48842	15
4 0	06899	11211	15499	19761	23998	28210	32398	36562	40702	44818	48910	16
15	06971	11283	15570	19831	24068	28280	32468	36631	40770	44886	48978	17
30	07043	11355	15641	19902	24139	28350	32537	36700	40839	44954	49046	18
45	07115	11426	15712	19973	24209	28420	32607	36769	40908	45023	49114	19
5 0	07187	11498	15784	20044	24279	28490	32676	36839	40977	45091	49182	20
15	07259	11570	15855	20115	24350	28560	32746	36908	41046	45160	49250	21
30	07331	11641	15926	20186	24420	28630	32816	36977	41114	45228	49318	22
45	07403	11713	15997	20256	24491	28700	32885	37046	41183	45296	49386	23
6 0	07475	11785	16068	20327	24561	28770	32955	37115	41252	45365	49454	24
15	07547	11856	16140	20398	24631	28840	33024	37184	41321	45433	49522	25
30	07619	11928	16211	20469	24702	28910	33094	37254	41389	45501	49590	26
45	07691	11999	16282	20539	24772	28980	33163	37323	41458	45570	49658	27
7 0	07763	12071	16353	20610	24842	29050	33233	37392	41527	45638	49726	28
15	07835	12142	16424	20681	24913	29120	33302	37461	41595	45706	49794	29
30	07907	12214	16495	20752	24983	29190	33372	37530	41664	45775	49862	30
45	07979	12286	16567	20822	25053	29259	33441	37599	41733	45843	49930	31
8 0	08051	12357	16638	20893	25123	29329	33511	37668	41802	45911	49998	32
15	08123	12429	16709	20964	25194	29399	33580	37737	41870	45980	50065	33
30	08195	12500	16780	21034	25264	29469	33650	37806	41939	46048	50133	34
45	08267	12572	16851	21105	25334	29539	33719	37875	42008	46116	50201	35
9 0	08339	12643	16922	21176	25405	29609	33789	37944	42076	46184	50269	36
15	08411	12715	16993	21246	25475	29679	33858	38013	42145	46253	50337	37
30	08483	12786	17064	21317	25545	29749	33928	38083	42214	46321	50405	38
45	08555	12858	17135	21388	25615	29818	33997	38152	42282	46389	50473	39
10 0	08627	12929	17206	21459	25686	29888	34067	38221	42351	46457	50541	40
15	08699	13001	17278	21529	25756	29958	34136	38290	42420	46526	50608	41
30	08771	13072	17349	21600	25826	30028	34205	38359	42488	46594	50676	42
45	08843	13144	17420	21670	25896	30098	34275	38428	42557	46662	50744	43
11 0	08915	13215	17491	21741	25967	30168	34344	38497	42625	46730	50812	44
15	08987	13287	17562	21812	26037	30237	34414	38566	42694	46798	50880	45
30	09058	13358	17633	21882	26107	30307	34483	38635	42763	46867	50948	46
45	09130	13430	17704	21953	26177	30377	34552	38704	42831	46935	51015	47
12 0	09202	13501	17775	22024	26247	30447	34622	38773	42900	47003	51083	48
15	09274	13573	17846	22094	26318	30517	34691	38842	42968	47071	51151	49
30	09346	13644	17917	22165	26388	30586	34761	38911	43037	47140	51219	50
45	09418	13715	17988	22235	26458	30656	34830	38980	43106	47208	51287	51
13 0	09490	13787	18059	22306	26528	30726	34899	39049	43174	47276	51354	52
15	09561	13858	18130	22376	26598	30796	34969	39118	43243	47344	51422	53
30	09633	13930	18201	22447	26668	30865	35038	39187	43311	47412	51490	54
45	09705	14001	18272	22518	26739	30935	35107	39255	43380	47480	51558	55
14 0	09777	14072	18343	22588	26809	31005	35177	39324	43448	47549	51626	56
15	09849	14144	18414	22659	26879	31075	35246	39393	43517	47617	51693	57
30	09920	14215	18485	22729	26949	31144	35315	39462	43585	47685	51761	58
45	09992	14287	18556	22800	27019	31214	35385	39531	43654	47753	51829	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 72.	Parts	5	10	14	19	24	29	34	38	43	48	53	58	62	67	72
D. 68.	Parts	4	9	13	18	23	27	32	36	40	45	50	54	59	63	68

LOG. SINE SQUARE

	50°				51°				52°			
	0	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	
	3h 20m	3h 21m	3h 22m	3h 23m	3h 24m	3h 25m	3h 26m	3h 27m	3h 28m	3h 29m	3h 30m	s.
′ ″	9·2	9·2	9·2	9·2	9·2	9·2	9·2	9·2	9·2	9·2	9·2	
0 0	51897	55949	59978	63985	67969	71930	75870	79788	83684	87558	91412	0
15	51964	56016	60045	64051	68035	71996	75936	79853	83749	87623	91476	1
30	52032	56083	60112	64118	68101	72062	76001	79918	83813	87687	91540	2
45	52100	56151	60179	64184	68177	72128	76067	79983	83878	87752	91604	3
1 0	52167	56218	60246	64251	68234	72194	76132	80048	83943	87816	91668	4
15	52235	56285	60313	64318	68300	72260	76197	80113	84008	87880	91732	5
30	52303	56353	60380	64384	68366	72325	76263	80178	84072	87945	91796	6
45	52360	56420	60447	64451	68432	72391	76328	80244	84138	88009	91860	7
2 0	52438	56487	60514	64517	68498	72457	76394	80309	84202	88073	91924	8
15	52506	56555	60580	64584	68564	72523	76459	80374	84266	88138	91988	9
30	52573	56622	60647	64650	68631	72589	76525	80439	84331	88202	92052	10
45	52641	56689	60714	64717	68697	72654	76590	80504	84396	88266	92116	11
3 0	52709	56756	60781	64783	68764	72720	76655	80569	84461	88331	92180	12
15	52776	56824	60848	64850	68829	72786	76721	80634	84525	88395	92244	13
30	52844	56891	60915	64916	68895	72852	76786	80699	84590	88459	92308	14
45	52912	56958	60982	64983	68961	72917	76852	80764	84655	88524	92372	15
4 0	52979	57025	61049	65049	69027	72983	76917	80829	84719	88588	92436	16
15	53047	57093	61116	65116	69093	73049	76982	80894	84784	88652	92500	17
30	53115	57160	61182	65182	69160	73115	77048	80959	84849	88717	92564	18
45	53182	57227	61249	65249	69226	73180	77113	81024	84913	88781	92627	19
5 0	53250	57294	61316	65315	69292	73246	77178	81089	84978	88845	92691	20
15	53317	57362	61383	65382	69358	73312	77244	81154	85042	88909	92755	21
30	53385	57429	61450	65448	69424	73378	77309	81219	85107	88974	92819	22
45	53453	57496	61517	65514	69490	73443	77374	81284	85172	89038	92883	23
6 0	53520	57563	61583	65581	69556	73509	77440	81349	85236	89102	92947	24
15	53588	57630	61650	65647	69622	73575	77505	81414	85301	89167	93011	25
30	53655	57698	61717	65714	69688	73640	77570	81479	85366	89231	93075	26
45	53723	57765	61784	65780	69754	73706	77636	81544	85430	89295	93139	27
7 0	53790	57832	61851	65847	69820	73772	77701	81609	85495	89359	93203	28
15	53858	57899	61917	65913	69886	73837	77766	81674	85559	89423	93266	29
30	53926	57966	61984	65979	69952	73903	77832	81739	85624	89488	93330	30
45	53993	58033	62051	66046	70018	73969	77897	81803	85688	89552	93394	31
8 0	54061	58101	62118	66112	70084	74034	77962	81868	85753	89616	93458	32
15	54128	58168	62184	66179	70150	74100	78028	81933	85818	89680	93522	33
30	54196	58235	62251	66245	70216	74166	78093	81998	85882	89745	93586	34
45	54263	58302	62318	66311	70282	74231	78158	82063	85947	89809	93650	35
9 0	54331	58369	62385	66378	70348	74297	78223	82128	86011	89873	93713	36
15	54398	58436	62452	66444	70414	74362	78289	82193	86076	89937	93777	37
30	54466	58503	62518	66510	70480	74428	78354	82258	86140	90001	93841	38
45	54533	58570	62585	66577	70546	74494	78419	82323	86205	90065	93905	39
10 0	54601	58637	62652	66643	70612	74559	78484	82388	86269	90130	93969	40
15	54668	58705	62718	66710	70678	74625	78550	82452	86334	90194	94033	41
30	54735	58772	62785	66776	70744	74691	78615	82517	86398	90258	94096	42
45	54803	58839	62852	66842	70810	74756	78680	82582	86463	90322	94160	43
11 0	54870	58906	62918	66908	70876	74822	78745	82647	86527	90386	94224	44
15	54938	58973	62985	66975	70942	74887	78810	82712	86592	90450	94288	45
30	55005	59040	63052	67041	71008	74953	78876	82777	86656	90514	94351	46
45	55073	59107	63118	67107	71074	75018	78941	82842	86721	90579	94415	47
12 0	55140	59174	63185	67174	71140	75084	79006	82906	86785	90643	94479	48
15	55208	59241	63252	67240	71206	75149	79071	82971	86850	90707	94543	49
30	55275	59308	63318	67306	71272	75215	79136	83036	86914	90771	94607	50
45	5534	59375	63385	67373	71338	75281	79202	83101	86979	90835	94670	51
13 0	55410	59442	63452	67439	71404	75346	79267	83166	87043	90899	94734	52
15	55477	59509	63518	67505	71469	75412	79332	83230	87108	90963	94798	53
30	55545	59576	63585	67571	71535	75477	79397	83295	87172	91027	94861	54
45	55612	59643	63652	67638	71601	75543	79462	83360	87236	91091	94925	55
14 0	55679	59710	63718	67704	71667	75608	79527	83425	87301	91155	94989	56
15	55747	59777	63785	67770	71733	75674	79593	83490	87365	91219	95053	57
30	55814	59844	63852	67836	71799	75739	79658	83554	87430	91284	95116	58
45	55881	59911	63918	67902	71865	75805	79723	83619	87494	91348	05180	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 68.	Parts	4	9	13	18	23	27	32	36	41	45	50	54	59	63	68
D. 64.	Parts	4	9	13	17	21	26	30	34	38	43	47	51	53	60	64

LOG. SINE SQUARE

	52°	53°				54°				55°		
	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	
′ ″	3h 31m	3h 32m	3h 33m	3h 34m	3h 35m	3h 36m	3h 37m	3h 38m	3h 39m	3h 40m	3h 41m	s.
	9·2	9·	9·3	9·3	9·3	9·3	9·3	9·3	9·3	9·3	9·3	
0 0	95244	299055	02845	06615	10364	14094	17803	21492	25161	28811	32442	0
15	95307	299118	02908	06678	10427	14155	17864	21553	25222	28872	32502	1
30	95371	299182	02971	06740	10489	14217	17926	21614	25283	28933	32562	2
45	95435	299245	03034	06803	10551	14279	17988	21676	25344	28993	32623	3
1 0	95498	299308	03097	06866	10614	14341	18049	21737	25405	29054	32683	4
15	95562	299372	03160	06928	10676	14403	18111	21798	25466	29114	32743	5
30	95626	299435	03223	06991	10738	14465	18172	21860	25527	29175	32804	6
45	95689	299498	03286	07053	10800	14527	18234	21921	25588	29236	32864	7
2 0	95753	299561	03349	07116	10863	14589	18296	21982	25649	29296	32924	8
15	95817	299625	03412	07179	10925	14651	18357	22043	25710	29357	32985	9
30	95880	299688	03475	07241	10987	14713	18419	22105	25771	29418	33045	10
45	95944	299751	03538	07304	11050	14775	18480	22166	25832	29478	33105	11
3 0	96008	299815	03601	07367	11112	14837	18542	22227	25893	29539	33166	12
15	96071	299878	03664	07429	11174	14899	18604	22289	25954	29599	33226	13
30	96135	299941	03727	07492	11236	14961	18665	22350	26015	29660	33286	14
45	96198	300004	03790	07554	11299	15023	18727	22411	26075	29721	33346	15
4 0	96262	300068	03853	07617	11361	15085	18788	22472	26136	29781	33407	16
15	96326	300131	03915	07679	11423	15146	18850	22533	26197	29842	33467	17
30	96389	300194	03978	07742	11485	15208	18911	22595	26258	29902	33527	18
45	96453	300257	04041	07804	11547	15270	18973	22656	26319	29963	33587	19
5 0	96516	300321	04104	07867	11610	15332	19035	22717	26380	30024	33648	20
15	96580	300384	04167	07930	11672	15394	19096	22778	26441	30084	33708	21
30	96644	300447	04230	07992	11734	15456	19158	22840	26502	30145	33768	22
45	96707	300510	04293	08055	11796	15518	19219	22901	26563	30205	33828	23
6 0	96771	300574	04356	08117	11858	15580	19281	22962	26624	30266	33889	24
15	96834	300637	04418	08180	11920	15641	19342	23023	26684	30326	33949	25
30	96898	300700	04481	08242	11983	15703	19404	23084	26745	30387	34009	26
45	96961	300763	04544	08305	12045	15765	19465	23146	26806	30447	34069	27
7 0	97025	300826	04607	08367	12107	15827	19527	23207	26867	30508	34129	28
15	97088	300889	04670	08430	12169	15888	19588	23268	26928	30568	34190	29
30	97152	300953	04733	08492	12231	15951	19650	23329	26989	30629	34250	30
45	97215	301016	04796	08555	12294	16012	19711	23390	27049	30689	34310	31
8 0	97279	301079	04858	08617	12356	16074	19773	23451	27110	30750	34370	32
15	97342	301142	04921	08680	12418	16136	19834	23512	27171	30810	34430	33
30	97406	301205	04984	08742	12480	16198	19896	23574	27232	30871	34490	34
45	97469	301268	05047	08805	12542	16260	19957	23635	27293	30931	34551	35
9 0	97533	301332	05110	08867	12604	16321	20019	23696	27354	30992	34611	36
15	97596	301395	05172	08929	12666	16383	20080	23757	27414	31052	34671	37
30	97660	301458	05235	08992	12729	16445	20141	23818	27475	31113	34731	38
45	97723	301521	05298	09054	12791	16508	20203	23879	27536	31173	34791	39
10 0	97787	301584	05361	09117	12853	16568	20264	23940	27597	31234	34851	40
15	97850	301647	05423	09179	12915	16630	20326	24001	27657	31294	34912	41
30	97914	301710	05486	09242	12977	16692	20387	24062	27718	31355	34972	42
45	97977	301773	05549	09304	13039	16754	20449	24124	27779	31415	35032	43
11 0	98041	301836	05612	09367	13101	16815	20510	24185	27840	31475	35092	44
15	98104	301900	05674	09429	13163	16877	20571	24246	27901	31536	35152	45
30	98167	301963	05737	09491	13225	16939	20633	24307	27961	31596	35212	46
45	98231	302026	05800	09554	13287	17001	20694	24368	28022	31657	35272	47
12 0	98294	302089	05863	09616	13349	17062	20756	24429	28083	31717	35332	48
15	98358	302152	05925	09679	13411	17124	20817	24490	28144	31778	35392	49
30	98421	302215	05988	09741	13473	17186	20878	24551	28204	31838	35452	50
45	98485	302278	06051	09803	13535	17247	20940	24612	28265	31898	35513	51
13 0	98548	302341	06114	09866	13597	17309	21001	24673	28326	31959	35573	52
15	98611	302404	06176	09928	13659	17371	21062	24734	28386	32019	35633	53
30	98675	302467	06239	09990	13722	17433	21124	24795	28447	32080	35693	54
45	98738	302530	06302	10053	13784	17494	21185	24856	28508	32140	35753	55
14 0	98801	302593	06364	10115	13846	17556	21246	24917	28568	32200	35813	56
15	98865	302656	06427	10177	13908	17618	21308	24978	28629	32261	35873	57
30	98928	302719	06490	10240	13970	17679	21369	25039	28690	32321	35933	58
45	98992	302782	06552	10302	14032	17741	21431	25100	28751	32381	35993	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 64.	Parts	4	9	13	17	21	26	30	34	38	43	47	51	55	60	64
D. 60	Parts	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60

LOG. SINE SQUARE

′ ″	55° 30′ 3h 42m	55° 45′ 3h 43m	56° 0′ 3h 44m	56° 15′ 3h 45m	56° 30′ 3h 46m	56° 45′ 3h 47m	57° 0′ 3h 48m	57° 15′ 3h 49m	57° 30′ 3h 50m	57° 45′ 3h 51m	58° 0′ 3h 52m	s.
	9·3	9·3	9·3	9·3	9·3	9·3	9·3	9·3	9·3	9·3	9·3	
0 0	36053	39645	43219	46773	50309	53827	57326	60807	64270	67715	71142	0
15	36113	39705	43278	46832	50368	53885	57384	60865	64327	67772	71199	1
30	36173	39765	43337	46891	50427	53944	57442	60923	64385	67830	71256	2
45	36233	39824	43397	46950	50485	54002	57500	60980	64443	67887	71313	3
1 0	36293	39884	43456	47009	50544	54060	57558	61038	64500	67944	71370	4
15	36353	39944	43515	47069	50603	54119	57617	61096	64558	68001	71427	5
30	36413	40003	43575	47128	50662	54177	57675	61154	64615	68059	71484	6
45	36473	40063	43634	47187	50720	54236	57733	61212	64673	68116	71541	7
2 0	36533	40123	43694	47246	50779	54294	57791	61270	64730	68173	71598	8
15	36593	40182	43753	47304	50838	54353	57849	61327	64788	68230	71655	9
30	36653	40242	43812	47364	50897	54411	57907	61385	64845	68287	71712	10
45	36713	40302	43872	47423	50955	54469	57965	61443	64903	68345	71769	11
3 0	36773	40361	43931	47482	51014	54528	58023	61501	64960	68402	71826	12
15	36833	40421	43990	47541	51073	54586	58082	61559	65018	68459	71883	13
30	36893	40481	44050	47600	51131	54645	58140	61616	65075	68516	71940	14
45	36953	40540	44109	47659	51190	54703	58198	61674	65133	68574	71996	15
4 0	37013	40600	44168	47718	51249	54762	58256	61732	65190	68631	72053	16
15	37073	40660	44228	47777	51308	54820	58314	61790	65248	68688	72110	17
30	37133	40719	44287	47836	51366	54878	58372	61848	65305	68745	72167	18
45	37193	40779	44346	47895	51425	54937	58430	61905	65363	68802	72224	19
5 0	37253	40838	44406	47954	51484	54995	58488	61963	65420	68859	72281	20
15	37312	40898	44465	48013	51542	55053	58546	62021	65478	68917	72338	21
30	37372	40958	44524	48072	51601	55112	58604	62079	65535	68974	72395	22
45	37432	41017	44583	48131	51660	55170	58662	62136	65593	69031	72452	23
6 0	37492	41077	44643	48190	51718	55228	58720	62194	65650	69088	72508	24
15	37552	41136	44702	48249	51777	55287	58778	62252	65707	69145	72565	25
30	37612	41196	44761	48308	51836	55345	58836	62310	65765	69202	72622	26
45	37672	41256	44820	48367	51894	55403	58894	62367	65822	69260	72679	27
7 0	37732	41315	44880	48426	51953	55462	58953	62425	65880	69317	72736	28
15	37792	41375	44939	48485	52012	55520	59011	62483	65937	69374	72793	29
30	37852	41434	44998	48543	52070	55578	59069	62541	65995	69431	72850	30
45	37911	41494	45057	48602	52129	55637	59127	62598	66052	69488	72906	31
8 0	37971	41553	45117	48661	52187	55695	59185	62656	66110	69545	72963	32
15	38031	41613	45176	48720	52246	55753	59243	62714	66167	69602	73020	33
30	38091	41672	45235	48779	52305	55812	59301	62771	66224	69659	73077	34
45	38151	41732	45294	48838	52363	55870	59359	62829	66282	69716	73133	35
9 0	38211	41792	45354	48897	52422	55928	59417	62887	66339	69774	73190	36
15	38270	41851	45413	48956	52480	55987	59475	62944	66396	69831	73247	37
30	38330	41911	45472	49015	52539	56045	59533	63002	66454	69888	73304	38
45	38390	41970	45531	49074	52598	56103	59591	63060	66511	69945	73361	39
10 0	38450	42030	45590	49133	52656	56161	59649	63118	66569	70002	73418	40
15	38510	42089	45650	49191	52715	56220	59706	63175	66626	70059	73474	41
30	38570	42149	45709	49250	52773	56278	59764	63233	66683	70116	73531	42
45	38629	42208	45768	49309	52832	56336	59822	63291	66741	70173	73588	43
11 0	38689	42268	45827	49368	52890	56394	59880	63348	66798	70230	73645	44
15	38749	42327	45886	49427	52949	56453	59938	63406	66855	70287	73701	45
30	38809	42386	45945	49486	53007	56511	59996	63463	66913	70344	73758	46
45	38869	42446	46005	49545	53066	56569	60054	63521	66970	70401	73815	47
12 0	38928	42505	46064	49603	53125	56627	60112	63579	67027	70458	73872	48
15	38988	42565	46123	49662	53183	56685	60170	63636	67085	70515	73928	49
30	39048	42624	46182	49721	53242	56744	60228	63694	67142	70572	73985	50
45	39108	42684	46241	49780	53300	56802	60286	63752	67199	70629	74042	51
13 0	39167	42743	46299	49839	53359	56860	60344	63809	67257	70686	74099	52
15	39227	42803	46359	49898	53417	56918	60402	63867	67314	70743	74155	53
30	39287	42862	46419	49956	53476	56977	60460	63924	67371	70800	74212	54
45	39347	42921	46478	50015	53534	57035	60517	63982	67429	70857	74269	55
14 0	39406	42981	46537	50074	53593	57093	60575	64040	67486	70914	74326	56
15	39466	43040	46596	50133	53651	57151	60633	64097	67543	70971	74382	57
30	39526	43100	46655	50192	53710	57209	60691	64155	67600	71028	74439	58
45	39586	43159	46714	50250	53768	57268	60749	64212	67658	71085	74496	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 60.	Parts	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60
D. 57.	Parts	4	8	11	15	19	23	27	30	34	38	42	46	49	53	57

LOG. SINE SQUARE

	58°			59°				60°				61°	
	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	
	3h 53m	3h 54m	3h 55m	3h 56m	3h 57m	3h 58m	3h 59m	4h 0m	4h 1m	4h 2m	4h 3m	4h 4m	s.
′ ″	9·3	9·3	9·3	9·3	9·3	9·39	9·39	9·	9·40	9·40	9·4	9·41	
0 0	74552	77945	81320	84678	88018	1342	4649	397940	1214	4471	07713	0938	0
15	74609	78001	81376	84733	88074	1398	4704	397995	1268	4526	07767	0991	1
30	74666	78057	81432	84789	88130	1453	4759	398049	1323	4580	07820	1045	2
45	74722	78114	81488	84845	88185	1508	4814	398104	1377	4634	07874	1099	3
1 0	74779	78170	81544	84901	88241	1563	4869	398159	1432	4688	07928	1152	4
15	74836	78227	81600	84957	88296	1619	4924	398213	1486	4742	07982	1206	5
30	74892	78283	81656	85012	88351	1674	4979	398268	1540	4796	08036	1259	6
45	74949	78339	81712	85068	88407	1729	5034	398323	1595	4850	08090	1313	7
2 0	75006	78396	81768	85124	88463	1784	5089	398377	1649	4905	08144	1367	8
15	75062	78452	81825	85180	88518	1839	5144	398432	1704	4959	08197	1420	9
30	75119	78508	81881	85236	88574	1895	5199	398487	1758	5013	08251	1474	10
45	75176	78565	81937	85291	88629	1950	5254	398541	1812	5067	08305	1527	11
3 0	75232	78621	81993	85347	88685	2005	5309	398596	1867	5121	08359	1581	12
15	75289	78677	82049	85403	88740	2060	5364	398651	1921	5175	08413	1634	13
30	75345	78734	82105	85459	88796	2116	5419	398705	1975	5229	08467	1688	14
45	75402	78790	82161	85514	88851	2171	5474	398760	2030	5283	08520	1741	15
4 0	75459	78846	82217	85570	88906	2226	5529	398814	2084	5337	08574	1795	16
15	75515	78903	82273	85626	88962	2281	5583	398869	2139	5391	08628	1849	17
30	75572	78959	82329	85681	89017	2336	5638	398924	2193	5446	08682	1902	18
45	75628	79015	82385	85737	89073	2391	5693	398979	2247	5500	08736	1956	19
5 0	75685	79072	82441	85793	89128	2447	5748	399033	2302	5554	08789	2009	20
15	75742	79128	82497	85849	89184	2502	5803	399088	2356	5608	08843	2063	21
30	75798	79184	82553	85905	89239	2557	5858	399142	2410	5662	08897	2116	22
45	75855	79240	82609	85960	89295	2612	5913	399197	2465	5716	08951	2170	23
6 0	75911	79297	82665	86016	89350	2667	5968	399252	2519	5770	09005	2223	24
15	75968	79353	82721	86072	89406	2722	6023	399306	2573	5824	09058	2277	25
30	76024	79409	82777	86127	89461	2778	6077	399361	2628	5878	09112	2330	26
45	76081	79466	82833	86183	89516	2833	6132	399415	2682	5932	09166	2384	27
7 0	76138	79522	82889	86239	89572	2888	6187	399470	2736	5986	09220	2437	28
15	76194	79578	82945	86294	89627	2943	6242	399524	2790	6040	09273	2491	29
30	76251	79634	83001	86350	89683	2998	6297	399579	2845	6094	09327	2544	30
45	76307	79691	83057	86406	89738	3053	6352	399633	2899	6148	09381	2598	31
8 0	76364	79747	83113	86461	89793	3108	6406	399688	2953	6202	09435	2651	32
15	76420	79803	83169	86517	89849	3163	6461	399742	3008	6256	09488	2705	33
30	76477	79859	83225	86573	89904	3218	6516	399797	3062	6310	09542	2758	34
45	76533	79916	83281	86629	89959	3274	6571	399852	3116	6364	09596	2812	35
9 0	76590	79972	83337	86684	90015	3329	6626	399906	3170	6418	09650	2865	36
15	76646	80028	83392	86740	90070	3384	6681	399961	3225	6472	09703	2919	37
30	76703	80084	83448	86795	90125	3439	6735	400015	3279	6526	09757	2972	38
45	76759	80140	83504	86851	90181	3494	6790	400070	3333	6580	09811	3025	39
10 0	76816	80197	83560	86907	90236	3549	6845	400124	3387	6634	09864	3079	40
15	76872	80253	83616	86962	90292	3604	6900	400179	3442	6688	09918	3132	41
30	76929	80309	83672	87018	90347	3659	6955	400233	3496	6742	09972	3186	42
45	76985	80365	83728	87074	90402	3714	7009	400288	3550	6796	10026	3239	43
11 0	77042	80421	83784	87129	90458	3769	7064	400342	3604	6850	10079	3293	44
15	77098	80478	83840	87185	90513	3824	7119	400397	3659	6904	10133	3346	45
30	77155	80534	83896	87240	90568	3879	7174	400451	3713	6958	10187	3399	46
45	77211	80590	83952	87296	90624	3934	7228	400506	3767	7012	10240	3453	47
12 0	77268	80646	84007	87351	90679	3989	7283	400560	3821	7066	10294	3506	48
15	77324	80702	84063	87407	90734	4045	7338	400615	3875	7120	10348	3560	49
30	77380	80758	84119	87463	90790	4100	7393	400669	3930	7174	10401	3613	50
45	77437	80815	84175	87518	90845	4155	7447	400724	3984	7228	10455	3666	51
13 0	77493	80871	84231	87574	90900	4210	7502	400778	4038	7281	10509	3720	52
15	77550	80927	84287	87630	90956	4265	7557	400833	4092	7335	10562	3773	53
30	77606	80983	84343	87685	91011	4320	7612	400887	4146	7389	10616	3827	54
45	77663	81039	84398	87741	91066	4375	7666	400942	4201	7443	10670	3880	55
14 0	77719	81095	84454	87796	91121	4430	7721	400996	4225	7497	10723	3933	56
15	77775	81151	84510	87852	91177	4485	7776	401051	4309	7551	10777	3987	57
30	77832	81208	84566	87907	91232	4540	7831	401105	4363	7605	10830	4040	58
45	77888	81264	84622	87962	91287	4595	7885	401159	4417	7659	10884	4093	59

	Sec.	1″	2″	3″	4″	5″	6″	7	8	9	10	11	12″	13	14	15″
D. 57.	Parts	4	8	11	15	19	23	27	30	34	38	42	46	49	53	57
D. 54.	Parts	3	7	10	14	18	21	24	28	32	36	39	42	46	49	54

LOG. SINE SQUARE

m	s	61° 15′	61° 30′	61° 45′	62° 0′	62° 15′	62° 30′	62° 45′	63° 0′	63° 15′	63° 30′	63° 45′	64° 0′	
		4h 5m	4h 6m	4h 7m	4h 8m	4h 9m	4h 10m	4h 11m	4h 12m	4h 13m	4h 14m	4h 15m	4h 16m	s.
′	′	9·41	9·4	9·42	9·42	9·42	9·4	9·43	9·4	9·4	9·4	9·4	9·4	
0	0	4147	17340	0517	3679	6825	29955	3070	36170	39255	42325	45379	48419	0
	15	4200	17393	0570	3731	6877	30007	3122	36222	39306	42376	45430	48470	1
	30	4253	17446	0623	3784	6929	30059	3174	36273	39358	42427	45481	48520	2
	45	4307	17499	0676	3836	6982	30111	3226	36325	39409	42478	45532	48571	3
1	0	4360	17552	0728	3889	7034	30163	3277	36376	39460	42529	45583	48622	4
	15	4413	17605	0781	3941	7086	30215	3329	36428	39511	42580	45633	48672	5
	30	4467	17658	0834	3994	7138	30267	3381	36479	39563	42631	45684	48723	6
	45	4520	17711	0887	4046	7191	30319	3433	36531	39614	42682	45735	48773	7
2	0	4573	17764	0940	4099	7243	30371	3484	36582	39665	42733	45786	48824	8
	15	4627	17817	0992	4152	7295	30423	3536	36634	39716	42784	45836	48874	9
	30	4680	17870	1045	4204	7347	30475	3588	36685	39768	42835	45887	48925	10
	45	4733	17924	1098	4257	7400	30527	3640	36737	39819	42886	45938	48975	11
3	0	4787	17977	1151	4309	7452	30579	3691	36788	39870	42937	45989	49026	12
	15	4840	18030	1203	4362	7504	30631	3743	36840	39921	42988	46039	49076	13
	30	4893	18083	1256	4414	7556	30683	3795	36891	39973	43039	46090	49127	14
	45	4946	18136	1309	4467	7609	30735	3847	36943	40024	43090	46141	49177	15
4	0	5000	18189	1362	4519	7661	30787	3898	36994	40075	43141	46192	49228	16
	15	5053	18242	1414	4572	7713	30839	3950	37046	40126	43192	46242	49278	17
	30	5106	18295	1467	4624	7765	30891	4002	37097	40177	43243	46293	49329	18
	45	5160	18348	1520	4677	7817	30943	4054	37149	40229	43294	46344	49379	19
5	0	5213	18401	1573	4729	7870	30995	4105	37200	40280	43345	46394	49430	20
	15	5266	18454	1625	4782	7922	31047	4157	37252	40331	43396	46445	49480	21
	30	5319	18507	1678	4834	7974	31099	4209	37303	40382	43446	46496	49530	22
	45	5373	18560	1731	4886	8026	31151	4260	37354	40433	43497	46546	49581	23
6	0	5426	18613	1784	4939	8079	31203	4312	37406	40485	43548	46597	49631	24
	15	5479	18666	1836	4991	8131	31255	4364	37457	40536	43599	46648	49682	25
	30	5532	18718	1889	5044	8183	31307	4415	37509	40587	43650	46699	49732	26
	45	5586	18771	1942	5096	8235	31359	4467	37560	40638	43701	46749	49783	27
7	0	5639	18824	1994	5149	8287	31411	4519	37611	40689	43752	46800	49833	28
	15	5692	18877	2047	5201	8340	31463	4570	37663	40741	43803	46851	49883	29
	30	5745	18930	2100	5254	8392	31515	4622	37714	40791	43854	46901	49934	30
	45	5798	18983	2152	5306	8444	31567	4674	37766	40843	43905	46952	49984	31
8	0	5852	19036	2205	5358	8496	31618	4725	37817	40894	43956	47003	50035	32
	15	5905	19089	2258	5411	8548	31670	4777	37869	40945	44007	47053	50085	33
	30	5958	19142	2311	5463	8600	31722	4829	37920	40996	44057	47104	50136	34
	45	6011	19195	2363	5516	8653	31774	4880	37971	41047	44108	47155	50186	35
9	0	6064	19248	2416	5568	8705	31826	4932	38023	41099	44159	47205	50236	36
	15	6118	19301	2469	5621	8757	31878	4984	38074	41150	44210	47256	50287	37
	30	6171	19354	2521	5673	8809	31930	5035	38125	41201	44261	47306	50337	38
	45	6224	19407	2574	5725	8861	31982	5087	38177	41252	44312	47357	50387	39
10	0	6277	19460	2627	5778	8913	32034	5139	38228	41303	44363	47408	50438	40
	15	6330	19513	2679	5830	8966	32085	5190	38280	41354	44414	47458	50488	41
	30	6384	19566	2732	5882	9018	32137	5242	38331	41405	44465	47509	50539	42
	45	6437	19618	2784	5935	9070	32189	5293	38382	41456	44515	47560	50589	43
11	0	6490	19671	2837	5987	9122	32241	5345	38434	41507	44566	47610	50639	44
	15	6543	19724	2890	6040	9174	32293	5397	38485	41559	44617	47661	50690	45
	30	6596	19777	2942	6092	9226	32345	5448	38536	41610	44668	47711	50740	46
	45	6649	19830	2995	6144	9278	32397	5500	38588	41661	44719	47762	50790	47
12	0	6702	19883	3048	6197	9330	32449	5551	38639	41712	44770	47813	50841	48
	15	6756	19936	3100	6249	9382	32500	5603	38691	41763	44821	47863	50891	49
	30	6809	19989	3153	6301	9434	32552	5655	38742	41814	44871	47914	50941	50
	45	6862	20042	3205	6354	9487	32604	5706	38793	41865	44922	47964	50992	51
13	0	6915	20094	3258	6406	9539	32656	5758	38844	41916	44973	48015	51042	52
	15	6968	20147	3311	6458	9591	32708	5809	38896	41967	45024	48065	51092	53
	30	7021	20200	3363	6511	9643	32759	5861	38947	42018	45075	48116	51143	54
	45	7074	20253	3416	6563	9695	32811	5912	38998	42069	45125	48167	51193	55
14	0	7127	20306	3468	6615	9747	32863	5964	39050	42120	45176	48217	51243	56
	15	7181	20359	3521	6668	9799	32915	6016	39101	42172	45227	48268	51294	57
	30	7234	20411	3574	6720	9851	32967	6067	39152	42223	45278	48318	51344	58
	45	7287	20464	3626	6772	9903	33018	6119	39204	42274	45329	48369	51394	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 53.	Parts	3	7	11	14	18	21	25	28	32	35	39	42	46	49	53
D. 50.	Parts	3	7	10	13	17	20	23	27	30	33	37	40	43	47	50

LOG. SINE SQUARE

	64°			65°				66°				
	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	
	4h 17m	4h 18m	4h 19m	4h 20m	4h 21m	4h 22m	4h 23m	4h 24m	4h 25m	4h 26m	4h 27m	s.
′ ″	9·4	9·4	9·4	9·4	9·4	9·4	9·4	9·4	9·4	9·4	9·4	
0 0	51445	54455	57451	60433	63400	66353	69293	72218	75128	78026	80909	0
15	51495	54505	57501	60483	63450	66403	69341	72266	75177	78074	80957	1
30	51546	54555	57551	60532	63499	66452	69390	72315	75225	78122	81005	2
45	51596	54605	57601	60582	63548	66501	69439	72363	75274	78170	81053	3
1 0	51646	54655	57651	60631	63598	66550	69488	72412	75322	78218	81101	4
15	51696	54706	57700	60681	63647	66599	69537	72461	75371	78267	81149	5
30	51746	54756	57750	60730	63696	66648	69586	72509	75419	78315	81197	6
45	51797	54806	57800	60780	63746	66697	69635	72558	75467	78363	81245	7
2 0	51847	54856	57850	60829	63795	66746	69683	72606	75516	78411	81293	8
15	51897	54906	57900	60879	63844	66795	69732	72655	75564	78459	81341	9
30	51947	54956	57949	60929	63894	66844	69781	72704	75612	78507	81388	10
45	51998	55006	57999	60978	63943	66893	69830	72752	75661	78555	81436	11
3 0	52048	55056	58049	61028	63992	66942	69879	72801	75709	78604	81484	12
15	52098	55106	58099	61077	64041	66992	69927	72849	75757	78652	81532	13
30	52148	55156	58148	61127	64091	67041	69976	72898	75806	78700	81580	14
45	52199	55206	58198	61176	64140	67090	70025	72947	75854	78748	81628	15
4 0	52249	55256	58248	61226	64189	67139	70074	72995	75902	78796	81676	16
15	52299	55306	58298	61275	64239	67188	70123	73044	75951	78844	81724	17
30	52349	55356	58347	61325	64288	67237	70171	73092	75999	78892	81771	18
45	52400	55406	58397	61374	64337	67286	70220	73141	76047	78940	81819	19
5 0	52450	55456	58447	61424	64386	67335	70269	73189	76096	78988	81867	20
15	52500	55506	58497	61473	64436	67384	70318	73238	76144	79036	81915	21
30	52550	55556	58546	61523	64485	67433	70366	73286	76192	79085	81963	22
45	52600	55605	58596	61572	64534	67482	70415	73335	76241	79133	82011	23
6 0	52651	55655	58646	61622	64583	67531	70464	73384	76289	79181	82059	24
15	52701	55705	58695	61671	64633	67580	70513	73432	76337	79229	82107	25
30	52751	55755	58745	61721	64682	67629	70562	73481	76386	79277	82154	26
45	52801	55805	58795	61770	64731	67678	70610	73529	76434	79325	82202	27
7 0	52851	55855	58845	61820	64780	67727	70659	73578	76482	79373	82250	28
15	52902	55905	58894	61869	64830	67776	70708	73626	76531	79421	82298	29
30	52952	55955	58944	61918	64879	67825	70757	73675	76579	79469	82346	30
45	53002	56005	58994	61968	64928	67874	70806	73723	76627	79517	82394	31
8 0	53052	56055	59043	62017	64977	67923	70854	73772	76675	79565	82441	32
15	53102	56105	59093	62067	65026	67972	70903	73820	76724	79613	82489	33
30	53152	56155	59143	62116	65076	68021	70952	73869	76772	79661	82537	34
45	53203	56205	59192	62166	65125	68070	71000	73917	76820	79709	82585	35
9 0	53253	56255	59242	62215	65174	68119	71049	73966	76869	79758	82633	36
15	53303	56305	59292	62265	65223	68168	71098	74014	76917	79806	82680	37
30	53353	56354	59341	62314	65272	68217	71147	74063	76065	79854	82728	38
45	53403	56404	59391	62363	65322	68265	71195	74111	77013	79902	82776	39
10 0	53453	56454	59441	62413	65371	68314	71244	74160	77062	79950	82824	40
15	53503	56504	59490	62462	65420	68363	71293	74208	77110	79998	82872	41
30	53554	56554	59540	62512	65469	68412	71342	74257	77158	80046	82919	42
45	53604	56604	59590	62561	65518	68461	71390	74305	77206	80094	82967	43
11 0	53654	56654	59639	62610	65567	68510	71439	74354	77254	80142	83015	44
15	53704	56704	59689	62660	65617	68559	71488	74402	77303	80190	83063	45
30	53754	56754	59739	62709	65666	68608	71536	74451	77351	80238	83110	46
45	53804	56803	59788	62759	65715	68657	71585	74499	77399	80286	83158	47
12 0	53854	56853	59838	62808	65764	68706	71634	74547	77447	80334	83206	48
15	53904	56903	59887	62857	65813	68755	71682	74596	77496	80382	83254	49
30	53954	56953	59937	62907	65862	68804	71731	74644	77544	80430	83302	50
45	54005	57003	59987	62956	65911	68853	71780	74693	77592	80478	83349	51
13 0	54055	57053	60036	63006	65961	68901	71828	74741	77640	80526	83397	52
15	54105	57103	60086	63055	66010	68950	71877	74790	77688	80573	83445	53
30	54155	57152	60135	63104	66059	68999	71926	74838	77737	80621	83493	54
45	54205	57202	60185	63154	66108	69048	71974	74886	77785	80669	83540	55
14 0	54255	57252	60235	63203	66157	69097	72023	74935	77833	80717	83588	56
15	54305	57302	60284	63252	66206	69146	72072	74983	77881	80765	83636	57
30	54355	57352	60334	63302	66255	69195	72120	75032	77929	80813	83684	58
45	54405	57402	60383	63351	66304	69241	72169	75080	77978	80861	83731	59

	Sec.	1″	2″	3″	4″	5″	6	7	8″	9″	10″	11″	12″	13″	14″	15″
D. 50.	Parts	3	7	10	13	17	20	23	27	30	33	37	40	43	47	50
D. 18.	Parts	3	6	10	13	16	19	22	26	29	32	35	38	42	45	48

LOG. SINE SQUARE

	67°				68°				69°			
	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	
	4ʰ 28ᵐ	4ʰ 29ᵐ	4ʰ 30ᵐ	4ʰ 31ᵐ	4ʰ 32ᵐ	4ʰ 33ᵐ	4ʰ 34ᵐ	4ʰ 35ᵐ	4ʰ 36ᵐ	4ʰ 37ᵐ	4ʰ 38ᵐ	s.
′ ″	9·4	9·4	9·4	9·4	9·4	9·	9·5	9·5	9·5	9·5	9·5	
0 0	83779	86635	89478	92307	95123	497926	00716	03492	06256	09007	11745	0
15	83827	86683	89525	92354	95170	497973	00762	03539	06302	09053	11790	1
30	83874	86730	89572	92401	95217	498019	00809	03585	06348	09098	11836	2
45	83922	86778	89620	92448	95264	498066	00855	03631	06394	09144	11881	3
1 0	83970	86825	89667	92495	95311	498112	00901	03677	06440	09190	11927	4
15	84017	86873	89714	92542	95357	498159	00948	03723	06486	09235	11972	5
30	84065	86920	89761	92589	95404	498206	00994	03769	06532	09281	12018	6
45	84113	86968	89809	92636	95451	498252	01040	03815	06578	09327	12063	7
2 0	84161	87015	89856	92683	95498	498299	01087	03862	06624	09373	12109	8
15	84208	87062	89903	92730	95545	498345	01133	03908	06669	09418	12154	9
30	84256	87110	89950	92778	95591	498392	01179	03954	06715	09464	12200	10
45	84304	87157	89998	92825	95638	498438	01226	04000	06761	09510	12245	11
3 0	84351	87205	90045	92872	95685	498485	01272	04046	06807	09555	12291	12
15	84399	87252	90092	92919	95732	498532	01318	04092	06853	09601	12336	13
30	84447	87300	90139	92966	95778	498578	01365	04138	06899	09647	12382	14
45	84494	87347	90186	93012	95825	498625	01411	04184	06945	09692	12427	15
4 0	84542	87395	90234	93059	95872	498671	01457	04231	06991	09738	12473	16
15	84590	87442	90281	93106	95919	498718	01504	04277	07037	09784	12518	17
30	84637	87489	90328	93153	95965	498764	01550	04323	07083	09830	12564	18
45	84685	87537	90375	93200	96012	498811	01596	04369	07128	09875	12609	19
5 0	84733	87584	90423	93247	96059	498857	01643	04415	07174	09921	12655	20
15	84780	87632	90470	93294	96106	498904	01689	04461	07220	09967	12700	21
30	84828	87679	90517	93341	96152	498951	01735	04507	07266	10012	12745	22
45	84875	87726	90564	93388	96199	498997	01782	04553	07312	10058	12791	23
6 0	84923	87774	90611	93435	96246	499044	01828	04599	07358	10103	12836	24
15	84971	87821	90658	93482	96293	499090	01874	04645	07404	10149	12882	25
30	85018	87869	90706	93529	96339	499137	01921	04692	07450	10195	12927	26
45	85066	87916	90753	93576	96386	499183	01967	04738	07495	10240	12973	27
7 0	85114	87963	90800	93623	96433	499230	02013	04784	07541	10286	13018	28
15	85161	88011	90848	93670	96480	499276	02059	04830	07587	10332	13064	29
30	85209	88058	90894	93717	96526	499323	02106	04876	07633	10377	13109	30
45	85256	88106	90941	93764	96573	499369	02152	04922	07679	10423	13154	31
8 0	85304	88153	90989	93811	96620	499416	02198	04968	07725	10469	13200	32
15	85352	88200	91036	93858	96666	499462	02245	05014	07771	10514	13245	33
30	85399	88248	91083	93905	96713	499509	02291	05060	07816	10560	13291	34
45	85447	88295	91130	93952	96760	499555	02337	05106	07862	10606	13336	35
9 0	85494	88342	91177	93998	96807	499601	02383	05152	07908	10651	13381	36
15	85542	88390	91224	94045	96853	499648	02430	05198	07954	10697	13427	37
30	85589	88437	91271	94092	96900	499694	02476	05244	08000	10742	13472	38
45	85637	88485	91318	94139	96947	499741	02522	05290	08045	10788	13518	39
10 0	85685	88532	91366	94186	96993	499787	02568	05336	08091	10833	13563	40
15	85732	88579	91413	94233	97040	499834	02615	05382	08137	10879	13608	41
30	85780	88627	91460	94280	97087	499880	02661	05428	08183	10925	13654	42
45	85827	88674	91507	94327	97133	499927	02707	05474	08229	10970	13699	43
11 0	85875	88721	91554	94374	97180	499973	02753	05520	08274	11016	13744	44
15	85922	88769	91601	94421	97227	500020	02799	05566	08320	11061	13790	45
30	85970	88816	91648	94467	97273	500066	02846	05612	08366	11107	13835	46
45	86017	88863	91695	94514	97320	500112	02892	05658	08412	11153	13881	47
12 0	86065	88910	91742	94561	97367	500159	02938	05704	08458	11198	13926	48
15	86113	88958	91790	94608	97413	500205	02984	05750	08503	11244	13971	49
30	86160	89005	91837	94655	97460	500252	03030	05796	08549	11289	14017	50
45	86208	89052	91884	94702	97507	500298	03077	05842	08595	11335	14062	51
13 0	86255	89100	91931	94749	97553	500345	03123	05888	08641	11380	14107	52
15	86303	89147	91978	94795	97600	500391	03169	05934	08687	11426	14153	53
30	86350	89194	92025	94842	97646	500437	03215	05980	08732	11471	14198	54
45	86398	89242	92072	94889	97693	500484	03261	06026	08778	11517	14243	55
14 0	86445	89289	92119	94936	97740	500530	03308	06072	08824	11563	14289	56
15	86493	89336	92166	94983	97786	500577	03354	06118	08870	11608	14334	57
30	86540	89383	92213	95030	97833	500623	03400	06164	08915	11654	14379	58
45	86588	89431	92260	95077	97879	500669	03446	06210	08961	11699	14425	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10	11	12	13	14	15″
D. 48.	Parts	3	6	10	13	16	19	22	26	29	32	35	38	42	45	48
D. 46	Parts	3	6	9	12	15	18	21	25	28	31	34	37	40	43	46

LOG. SINE SQUARE

m s	69° 45′ 4h 39m	70° 0′ 4h 40m	70° 15′ 4h 41m	70° 30′ 4h 42m	70° 45′ 4h 43m	71° 0′ 4h 44m	71° 15′ 4h 45m	71° 30′ 4h 46m	71° 45′ 4h 47m	72° 0′ 4h 48m	72° 15′ 4h 49m	n.
	9·5	9·5	9·5	9·5	9·5	9·5	9·5	9·5	9·5	9·5	9·5	
0 0	14470	17183	19883	22570	25245	27908	30559	33197	35823	38437	41040	0
15	14515	17228	19927	22615	25290	27952	30603	33241	35867	38481	41083	1
30	14561	17273	19972	22659	25334	27997	30647	33285	35910	38524	41126	2
45	14606	17318	20017	22704	25379	28041	30691	33329	35954	38568	41169	3
1 0	14651	17363	20062	22749	25423	28085	30735	33372	35998	38611	41213	4
15	14696	17408	20107	22794	25468	28129	30779	33416	36041	38655	41256	5
30	14742	17453	20152	22838	25512	28174	30823	33460	36085	38698	41299	6
45	14787	17498	20197	22883	25557	28218	30867	33504	36129	38742	41342	7
2 0	14832	17543	20242	22928	25601	28262	30911	33548	36172	38785	41386	8
15	14878	17588	20287	22972	25645	28306	30955	33592	36216	38828	41429	9
30	14923	17633	20331	23017	25690	28351	30999	33635	36260	38872	41472	10
45	14968	17678	20376	23062	25734	28395	31043	33679	36303	38915	41515	11
3 0	15014	17724	20421	23106	25779	28439	31087	33723	36347	38959	41559	12
15	15059	17769	20466	23151	25823	28483	31131	33767	36391	39002	41602	13
30	15104	17814	20511	23195	25868	28528	31175	33811	36434	39046	41645	14
45	15149	17859	20556	23240	25912	28572	31219	33854	36478	39089	41688	15
4 0	15195	17904	20600	23285	25957	28616	31263	33898	36521	39132	41731	16
15	15240	17949	20645	23329	26001	28660	31307	33942	36565	39176	41775	17
30	15285	17994	20690	23374	26045	28704	31351	33986	36609	39219	41818	18
45	15330	18039	20735	23419	26090	28749	31395	34030	36652	39263	41861	19
5 0	15376	18084	20780	23463	26134	28793	31439	34074	36696	39306	41904	20
15	15421	18129	20825	23508	26179	28837	31483	34117	36740	39349	41948	21
30	15466	18174	20869	23552	26223	28881	31527	34161	36783	39393	41991	22
45	15511	18219	20914	23597	26267	28926	31571	34205	36827	39436	42034	23
6 0	15557	18264	20959	23642	26312	28970	31615	34249	36870	39480	42077	24
15	15602	18309	21004	23686	26356	29014	31659	34293	36914	39523	42120	25
30	15647	18354	21049	23731	26401	29058	31703	34336	36957	39566	42164	26
45	15692	18399	21094	23775	26445	29102	31747	34380	37001	39610	42207	27
7 0	15737	18444	21138	23820	26489	29146	31791	34424	37045	39653	42250	28
15	15783	18489	21183	23865	26534	29191	31835	34468	37088	39697	42293	29
30	15828	18534	21228	23909	26578	29235	31879	34511	37132	39740	42336	30
45	15873	18579	21273	23954	26623	29279	31923	34555	37175	39783	42379	31
8 0	15918	18624	21317	23998	26667	29323	31967	34599	37219	39827	42423	32
15	15963	18669	21362	24043	26711	29367	32011	34643	37262	39870	42466	33
30	16009	18714	21407	24087	26756	29411	32055	34687	37306	39913	42509	34
45	16054	18759	21452	24132	26800	29456	32099	34730	37350	39957	42552	35
9 0	16099	18804	21497	24177	26844	29500	32143	34774	37393	40000	42595	36
15	16144	18849	21541	24221	26889	29544	32187	34818	37437	40043	42638	37
30	16189	18894	21586	24266	26933	29588	32231	34862	37480	40087	42681	38
45	16235	18939	21631	24310	26977	29632	32275	34905	37524	40130	42725	39
10 0	16280	18984	21676	24355	27022	29676	32319	34949	37567	40173	42768	40
15	16325	19029	21720	24400	27066	29721	32363	34993	37611	40217	42811	41
30	16370	19074	21765	24444	27110	29765	32407	35037	37654	40260	42854	42
45	16415	19119	21810	24489	27155	29809	32451	35080	37698	40304	42897	43
11 0	16460	19164	21855	24533	27199	29853	32495	35124	37741	40347	42940	44
15	16506	19209	21899	24578	27244	29897	32538	35168	37785	40390	42983	45
30	16551	19254	21944	24622	27288	29941	32582	35211	37828	40434	43027	46
45	16596	19299	21989	24667	27332	29985	32626	35255	37872	40477	43070	47
12 0	16641	19344	22034	24711	27376	30029	32670	35299	37915	40520	43113	48
15	16686	19389	22078	24756	27421	30074	32714	35343	37959	40563	43156	49
30	16731	19433	22123	24800	27465	30118	32758	35386	38002	40607	43199	50
45	16777	19478	22168	24845	27509	30162	32802	35430	38046	40650	43242	51
13 0	16822	19523	22213	24889	27554	30206	32846	35474	38089	40693	43285	52
15	16867	19568	22257	24934	27598	30250	32890	35517	38133	40737	43328	53
30	16912	19613	22302	24978	27642	30294	32934	35561	38176	40780	43371	54
45	16957	19658	22347	25023	27687	30338	32978	35605	38220	40823	43414	55
14 0	17002	19703	22391	25067	27731	30382	33021	35648	38263	40866	43458	56
15	17047	19748	22436	25112	27775	30426	33065	35692	38307	40910	43501	57
30	17092	19793	22481	25156	27819	30470	33109	35736	38350	40953	43544	58
45	17137	19838	22525	25201	27864	30514	33153	35779	38394	40996	43587	59

	Sec.	1″	2	3″	4″	5″	6″	7″	8″	9″	10″	11	12	13″	14	15″
D. 45.	Parts	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
D. 43.	Parts	3	6	9	12	14	17	20	23	26	29	32	35	37	40	43

LOG. SINE SQUARE

	72°		73°				74°				75°	
	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	
	4h 50m	4h 51m	4h 52m	4h 53m	4h 54m	4h 55m	4h 56m	4h 57m	4h 58m	4h 59m	5h 0m	s.
′ ″	9·5	9·5	9·5	9·5	9·5	9·5	9·5	9·5	9·5	9·5	9·5	
0 0	43630	46208	48775	51330	53874	56406	58926	61435	63933	66419	68894	0
15	43673	46251	48818	51373	53916	56448	58968	61477	63974	66460	68935	1
30	43716	46294	48861	51415	53958	56490	59010	61519	64016	66502	68977	2
45	43759	46337	48903	51458	54001	56532	59052	61560	64057	66543	69018	3
1 0	43802	46380	48946	51500	54043	56574	59094	61602	64099	66584	69059	4
15	43845	46423	48989	51543	54085	56616	59136	61644	64140	66626	69100	5
30	43888	46466	49031	51585	54127	56658	59177	61685	64182	66667	69141	6
45	43931	46508	49074	51628	54170	56700	59219	61727	64223	66708	69182	7
2 0	43974	46551	49116	51670	54212	56742	59261	61769	64265	66750	69223	8
15	44017	46594	49159	51713	54254	56784	59303	61810	64306	66791	69265	9
30	44061	46637	49202	51755	54296	56826	59345	61852	64348	66832	69306	10
45	44104	46680	49244	51797	54339	56869	59387	61894	64389	66874	69347	11
3 0	44147	46723	49287	51840	54381	56911	59429	61935	64431	66915	69388	12
15	44190	46766	49330	51882	54423	56953	59471	61977	64472	66956	69429	13
30	44233	46808	49372	51925	54465	56995	59512	62019	64514	66998	69470	14
45	44276	46851	49415	51967	54508	57037	59554	62060	64555	67039	69511	15
4 0	44319	46894	49458	52010	54550	57079	59596	62102	64597	67080	69552	16
15	44362	46937	49500	52052	54592	57121	59638	62144	64638	67121	69593	17
30	44405	46980	49543	52095	54634	57163	59680	62186	64680	67163	69635	18
45	44448	47022	49586	52137	54677	57205	59722	62227	64721	67204	69676	19
5 0	44491	47065	49628	52179	54719	57247	59764	62269	64763	67245	69717	20
15	44534	47108	49671	52222	54761	57289	59806	62311	64804	67287	69758	21
30	44577	47151	49713	52264	54803	57331	59847	62352	64846	67328	69799	22
45	44620	47194	49756	52307	54846	57373	59889	62394	64887	67369	69840	23
6 0	44663	47237	49799	52349	54888	57415	59931	62435	64929	67410	69881	24
15	44706	47279	49841	52391	54930	57457	59973	62477	64970	67452	69922	25
30	44749	47322	49884	52434	54972	57499	60015	62519	65011	67493	69963	26
45	44792	47365	49926	52476	55014	57541	60056	62560	65053	67534	70004	27
7 0	44835	47408	49969	52519	55057	57583	60098	62602	65094	67576	70045	28
15	44878	47451	50012	52561	55099	57625	60140	62644	65136	67617	70087	29
30	44921	47493	50054	52603	55141	57667	60182	62685	65177	67658	70128	30
45	44964	47536	50097	52646	55183	57709	60224	62727	65219	67699	70169	31
8 0	45007	47579	50139	52688	55225	57751	60266	62769	65260	67741	70210	32
15	45050	47622	50182	52731	55268	57793	60307	62810	65302	67782	70251	33
30	45093	47664	50224	52773	55310	57835	60349	62852	65343	67823	70292	34
45	45135	47707	50267	52815	55352	57877	60391	62893	65384	67864	70333	35
9 0	45178	47750	50310	52858	55394	57919	60433	62935	65426	67905	70374	36
15	45221	47793	50352	52900	55436	57961	60475	62977	65467	67947	70415	37
30	45264	47835	50395	52942	55479	58003	60516	63018	65509	67988	70456	38
45	45307	47878	50437	52985	55521	58045	60558	63060	65550	68029	70497	39
10 0	45350	47921	50480	53027	55563	58087	60600	63101	65592	68070	70538	40
15	45393	47964	50522	53070	55605	58129	60642	63143	65633	68112	70579	41
30	45436	48006	50565	53112	55647	58171	60684	63185	65674	68153	70620	42
45	45479	48049	50608	53154	55689	58213	60725	63226	65716	68194	70661	43
11 0	45522	48092	50650	53197	55732	58255	60767	63268	65757	68235	70702	44
15	45565	48135	50693	53239	55774	58297	60809	63309	65799	68277	70743	45
30	45608	48177	50735	53281	55816	58339	60851	63351	65840	68318	70784	46
45	45651	48220	50778	53324	55858	58381	60892	63393	65881	68359	70825	47
12 0	45694	48263	50820	53366	55900	58423	60934	63434	65923	68400	70866	48
15	45737	48305	50863	53408	55942	58465	60976	63476	65964	68441	70907	49
30	45779	48348	50905	53451	55984	58507	61018	63517	66005	68482	70948	50
45	45822	48391	50948	53493	56027	58549	61059	63559	66047	68524	70989	51
13 0	45865	48434	50990	53535	56069	58591	61101	63600	66088	68565	71030	52
15	45908	48476	51033	53578	56111	58633	61143	63642	66130	68606	71071	53
30	45951	48519	51075	53620	56153	58675	61185	63683	66171	68647	71112	54
45	45994	48562	51118	53662	56195	58713	61226	63725	66212	68688	71153	55
14 0	46037	48604	51160	53704	56237	58758	61268	63767	66254	68730	71194	56
15	46080	48647	51203	53747	56279	58800	61310	63808	66295	68771	71235	57
30	46123	48690	51245	53789	56321	58842	61352	63850	66336	68812	71276	58
45	46166	48732	51288	53831	56363	58884	61393	63891	66378	68853	71317	59

	Sec.	1″	2″	3	4	5″	6″	7″	8″	9	10″	11″	12″	13″	14″	15″
D. 43.	Parts	3	6	9	12	14	17	20	23	26	29	32	35	37	40	43
D. 41.	Parts	3	5	8	11	14	16	19	22	24	27	30	33	35	38	41

LOG. SINE SQUARE

	75°			76°				77°				
	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	
	5h 1m	5h 2m	5h 3m	5h 4m	5h 5m	5h 6m	5h 7m	5h 8m	5h 9m	5h 10m	5h 11m	s.
	9·5	9·5	9·5	9·5	9·5	9·5	9·5	9·5	9·5	9·5	9·5	
0 0	71358	73811	76253	78684	81104	83513	85911	88299	90676	93042	95398	0
15	71399	73852	76294	78724	81144	83553	85951	88339	90716	93082	95437	1
30	71440	73893	76334	78765	81185	83593	85991	88379	90755	93121	95477	2
45	71481	73933	76375	78805	81225	83633	86031	88418	90795	93161	95516	3
1 0	71522	73974	76415	78846	81265	83673	86071	88458	90834	93200	95555	4
15	71563	74015	76456	78886	81305	83713	86111	88498	90874	93239	95594	5
30	71604	74056	76497	78926	81345	83753	86151	88537	90913	93279	95633	6
45	71645	74097	76537	78967	81386	83793	86191	88577	90953	93318	95672	7
2 0	71686	74137	76578	79007	81426	83834	86230	88617	90992	93357	95712	8
15	71727	74178	76618	79048	81466	83874	86270	88656	91032	93397	95751	9
30	71768	74219	76659	79088	81506	83914	86310	88696	91071	93436	95790	1
45	71809	74260	76700	79128	81546	83954	86350	88736	91111	93475	95829	11
3 0	71850	74300	76740	79169	81587	83994	86390	88775	91150	93514	95868	12
15	71891	74341	76781	79209	81627	84034	86430	88815	91190	93554	95907	13
30	71932	74382	76821	79250	81667	84074	86470	88855	91229	93593	95946	14
45	71973	74423	76862	79290	81707	84114	86509	88894	91269	93632	95986	15
4 0	72013	74463	76902	79330	81747	84154	86549	88934	91308	93672	96025	16
15	72054	74504	76943	79371	81788	84194	86589	88974	91348	93711	96064	17
30	72095	74545	76983	79411	81828	84234	86629	89013	91387	93750	96103	18
45	72136	74586	77024	79451	81868	84274	86669	89053	91427	93790	96142	19
5 0	72177	74626	77065	79492	81908	84314	86709	89093	91466	93829	96181	20
15	72218	74667	77105	79532	81948	84354	86748	89132	91506	93868	96220	21
30	72259	74708	77146	79573	81989	84394	86788	89172	91545	93907	96259	22
45	72300	74748	77186	79613	82029	84434	86828	89212	91584	93947	96299	23
6 0	72341	74789	77227	79653	82069	84474	86868	89251	91624	93986	96338	24
15	72382	74830	77267	79694	82109	84514	86908	89291	91663	94025	96377	25
30	72423	74871	77308	79734	82149	84554	86947	89330	91703	94065	96416	26
45	72463	74911	77348	79774	82189	84594	86987	89370	91742	94104	96455	27
7 0	72504	74952	77389	79815	82230	84634	87027	89410	91782	94143	96494	28
15	72545	74993	77429	79855	82270	84674	87067	89449	91821	94182	96533	29
30	72586	75033	77470	79895	82310	84714	87107	89489	91861	94222	96572	30
45	72627	75074	77510	79936	82350	84754	87146	89529	91900	94261	96611	31
8 0	72668	75115	77551	79976	82390	84794	87186	89568	91939	94300	96650	32
15	72709	75156	77591	80016	82430	84834	87226	89608	91979	94339	96689	33
30	72750	75196	77632	80057	82470	84874	87266	89647	92018	94379	96729	34
45	72791	75237	77672	80097	82511	84913	87306	89687	92058	94418	96768	35
9 0	72831	75278	77713	80137	82551	84953	87345	89727	92097	94457	96807	36
15	72872	75318	77754	80178	82591	84993	87385	89766	92137	94496	96846	37
30	72913	75359	77794	80218	82631	85033	87425	89806	92176	94536	96885	38
45	72954	75400	77834	80258	82671	85073	87465	89845	92215	94575	96924	39
10 0	72995	75440	77875	80298	82711	85113	87504	89885	92255	94614	96963	40
15	73036	75481	77915	80339	82751	85153	87544	89925	92294	94653	97002	41
30	73076	75522	77956	80379	82791	85193	87584	89964	92334	94693	97041	42
45	73117	75562	77996	80419	82832	85233	87624	90004	92373	94732	97080	43
11 0	73158	75603	78037	80460	82872	85273	87663	90043	92412	94771	97119	44
15	73199	75644	78077	80500	82912	85313	87703	90083	92452	94810	97158	45
30	73240	75684	78118	80540	82952	85353	87743	90122	92491	94850	97197	46
45	73281	75725	78158	80581	82992	85393	87783	90162	92531	94889	97236	47
12 0	73321	75766	78199	80621	83032	85433	87822	90202	92570	94928	97275	48
15	73362	75806	78239	80661	83072	85473	87862	90241	92609	94967	97314	49
30	73403	75847	78279	80701	83112	85513	87902	90281	92649	95006	97353	50
45	73444	75887	78320	80742	83152	85552	87942	90320	92688	95046	97392	51
13 0	73485	75928	78360	80782	83193	85592	87981	90360	92728	95085	97432	52
15	73526	75969	78401	80822	83233	85632	88021	90399	92767	95124	97471	53
30	73566	76009	78441	80862	83273	85672	88061	90439	92806	95163	97510	54
45	73607	76050	78482	80903	83313	85712	88101	90478	92846	95202	97549	55
14 0	73648	76091	78522	80943	83353	85752	88140	90518	92885	95242	97588	56
15	73689	76131	78563	80983	83393	85792	88180	90558	92924	95281	97627	57
30	73730	76172	78603	81023	83433	85832	88220	90597	92964	95320	97666	58
45	73770	76212	78644	81064	83473	85872	88259	90637	93003	95359	97705	59

	Sec.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
D. 41.	Parts	3	5	8	11	14	16	19	22	24	27	30	33	35	38	41
D. 39	Parts	3	5	8	10	13	15	18	21	23	26	29	31	33	36	39

LOG. SINE SQUARE

	78°				79°				80°			
	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	
′ ″	5h 12m	5h 13m	5h 14m	5h 15m	5h 16m	5h 17m	5h 18m	5h 19m	5h 20m	5h 21m	5h 22m	s.
	9·	9·6	9·6	9·6	9·6	9·6	9·6	9·6	9·6	9·6	9·6	
0 0	597744	00078	02403	04717	07021	09315	11598	13872	16135	18388	20632	0
15	597783	00117	02442	04756	07059	09353	11636	13909	16173	18426	20669	1
30	597822	00156	02480	04794	07098	09391	11674	13947	16210	18463	20706	2
45	597861	00195	02519	04833	07136	09429	11712	13985	16248	18501	20744	3
1 0	597900	00234	02558	04871	07174	09467	11750	14023	16285	18538	20781	4
15	597939	00273	02596	04910	07213	09505	11788	14061	16323	18576	20818	5
30	597978	00311	02635	04948	07251	09544	11826	14098	16361	18613	20855	6
45	598017	00350	02674	04986	07289	09582	11864	14136	16398	18651	20893	7
2 0	598056	00389	02712	05025	07327	09620	11902	14174	16436	18688	20930	8
15	598095	00428	02751	05063	07366	09658	11940	14212	16474	18725	20967	9
30	598133	00467	02789	05102	07404	09696	11978	14250	16511	18763	21005	10
45	598172	00505	02828	05140	07442	09734	12016	14287	16549	18800	21042	11
3 0	598211	00544	02867	05179	07481	09772	12054	14325	16586	18838	21079	12
15	598250	00583	02905	05217	07519	09810	12092	14363	16624	18875	21116	13
30	598289	00622	02944	05256	07557	09848	12130	14401	16662	18913	21154	14
45	598328	00661	02982	05294	07595	09886	12168	14438	16699	18950	21191	15
4 0	598367	00699	03021	05332	07634	09925	12205	14476	16737	18987	21228	16
15	598406	00738	03060	05371	07672	09963	12243	14514	16774	19025	21266	17
30	598445	00777	03098	05409	07710	10001	12281	14552	16812	19062	21303	18
45	598484	00816	03137	05448	07748	10039	12319	14589	16850	19100	21340	19
5 0	598523	00854	03175	05486	07787	10077	12357	14627	16887	19137	21377	20
15	598562	00893	03214	05525	07825	10115	12395	14665	16925	19175	21415	21
30	598601	00932	03253	05563	07863	10153	12433	14703	16962	19212	21452	22
45	598640	00971	03291	05601	07901	10191	12471	14740	17000	19249	21489	23
6 0	598679	01009	03330	05640	07940	10229	12509	14778	17037	19287	21526	24
15	598718	01048	03368	05678	07978	10267	12547	14816	17075	19324	21564	25
30	598757	01087	03407	05717	08016	10305	12585	14854	17113	19362	21601	26
45	598796	01126	03446	05755	08054	10343	12622	14891	17150	19399	21638	27
7 0	598834	01164	03484	05794	08093	10381	12660	14929	17188	19436	21675	28
15	598873	01203	03523	05832	08131	10420	12698	14967	17225	19474	21712	29
30	598912	01242	03561	05870	08169	10458	12736	15005	17263	19511	21749	30
45	598951	01281	03600	05909	08207	10496	12774	15042	17300	19549	21787	31
8 0	598990	01319	03638	05947	08246	10534	12812	15080	17338	19586	21824	32
15	599029	01358	03677	05986	08284	10572	12850	15118	17376	19623	21861	33
30	599068	01397	03716	06024	08322	10610	12888	15155	17413	19661	21899	34
45	599107	01436	03754	06062	08360	10648	12926	15193	17451	19698	21936	35
9 0	599146	01474	03793	06101	08398	10686	12963	15231	17488	19736	21973	36
15	599185	01513	03831	06139	08437	10724	13001	15269	17526	19773	22010	37
30	599224	01552	03870	06177	08475	10762	13039	15306	17563	19810	22047	38
45	599262	01591	03908	06216	08513	10800	13077	15344	17601	19848	22085	39
10 0	599301	01629	03947	06254	08551	10838	13115	15383	17638	19885	22122	40
15	599340	01668	03986	06293	08589	10876	13153	15419	17676	19922	22159	41
30	599379	01707	04024	06331	08628	10914	13191	15457	17713	19960	22196	42
45	599418	01745	04063	06369	08666	10952	13229	15495	17751	19997	22233	43
11 0	599457	01784	04101	06408	08704	10990	13266	15532	17788	20034	22271	44
15	599496	01823	04140	06446	08742	11028	13304	15570	17826	20072	22308	45
30	599535	01861	04178	06484	08780	11066	13342	5608	17863	20109	22345	46
45	599574	01900	04217	06523	08819	11104	13380	15645	17901	20146	22382	47
12 0	599612	01939	04255	06561	08857	11142	13418	15683	17938	20184	22419	48
15	599651	01978	04294	06599	08895	11180	13456	15721	17976	20221	22456	49
30	599690	02016	04332	06638	08933	11218	13493	15758	18013	20258	22494	50
45	599729	02055	04371	06676	08971	11256	13531	15796	18051	20296	22531	51
13 0	599768	02094	04409	06714	09009	11294	13569	15834	18088	20333	22568	52
15	599807	02132	04448	06753	09048	11332	13607	15871	18126	20371	22605	53
30	599845	02171	04486	06791	09086	11370	13645	15909	18163	20408	22642	54
45	599884	02210	04525	06829	09124	11408	13683	15947	18201	20445	22679	55
14 0	599923	02248	04563	06868	09162	11446	13720	15984	18238	20482	22717	56
15	599962	02287	04602	06906	09200	11484	13758	16022	18276	20520	22754	57
30	600001	02326	04640	06944	09238	11522	13796	16060	18313	20557	22791	58
45	600040	02364	04679	06983	09277	11560	13834	16097	18351	20594	22828	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 39.	Parts	3	5	8	10	13	15	18	21	23	26	29	31	33	36	39
D. 37.	Parts	2	5	7	10	12	15	17	20	22	25	27	29	32	34	37

LOG. SINE SQUARE

	80°	81°				82°				83°		
	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	
	$5^h 23^m$	$5^h 24^m$	$5^h 25^m$	$5^h 26^m$	$5^h 27^m$	$5^h 28^m$	$5^h 29^m$	$5^h 30^m$	$5^h 31^m$	$5^h 32^m$	$5^h 33^m$	s.
′ ″	9·6	9·6	9·6	9·6	9·6	9·6	9·6	9·6	9·6	9·6	9·6	
0 0	22865	25089	27303	29507	31701	33886	36061	38226	40383	42529	44666	0
15	22902	25126	27339	29543	31738	33922	36097	38263	40418	42565	44702	1
30	22939	25163	27376	29580	31774	33958	36133	38299	40454	42601	44737	2
45	22977	25200	27413	29617	31811	33995	36169	38335	40490	42636	44773	3
1 0	23014	25237	27450	29653	31847	34031	36206	38371	40526	42672	44808	4
15	23051	25274	27487	29690	31884	34067	36242	38407	40562	42708	44844	5
30	23088	25311	27524	29727	31920	34104	36278	38443	40598	42743	44880	6
45	23125	25348	27560	29763	31956	34140	36314	38479	40633	42779	44915	7
2 0	23162	25385	27597	29800	31993	34176	36350	38515	40669	42815	44951	8
15	23199	25422	27634	29837	32029	34213	36386	38551	40705	42850	44986	9
30	23237	25459	27671	29873	32066	34249	36422	38587	40741	42886	45022	10
45	23274	25495	27707	29910	32102	34285	36459	38622	40777	42922	45057	11
3 0	23311	25532	27744	29946	32139	34322	36495	38658	40813	42957	45093	12
15	23348	25569	27781	29983	32175	34358	36531	38694	40848	42993	45128	13
30	23385	25606	27818	30020	32212	34394	36567	38730	40884	43029	45164	14
45	23422	25643	27855	30056	32248	34430	36603	38766	40920	43064	45199	15
4 0	23459	25680	27891	30093	32285	34467	36639	38802	40956	43100	45235	16
15	23496	25717	27928	30129	32321	34503	36676	38838	40992	43136	45270	17
30	23533	25754	27965	30166	32357	34539	36712	38874	41027	43171	45306	18
45	23570	25791	28002	30203	32394	34576	36748	38910	41063	43207	45341	19
5 0	23607	25828	28038	30239	32430	34612	36784	38946	41099	43243	45377	20
15	23645	25865	28075	30276	32467	34648	36820	38982	41135	43278	45412	21
30	23682	25902	28112	30312	32503	34684	36856	39018	41171	43314	45448	22
45	23719	25939	28149	30349	32540	34721	36892	39054	41206	43349	45483	23
6 0	23756	25975	28185	30386	32576	34757	36928	39090	41242	43385	45519	24
15	23793	26012	28222	30422	32613	34793	36964	39126	41278	43421	45554	25
30	23830	26049	28259	30459	32649	34829	37000	39162	41314	43456	45590	26
45	23867	26086	28296	30495	32685	34866	37037	39198	41350	43492	45625	27
7 0	23904	26123	28332	30532	32722	34902	37073	39234	41385	43528	45660	28
15	23941	26160	28369	30569	32758	34938	37109	39270	41421	43563	45696	29
30	23978	26197	28406	30605	32795	34975	37145	39306	41457	43599	45731	30
45	24015	26234	28443	30642	32831	35011	37181	39342	41493	43635	45767	31
8 0	24052	26271	28479	30678	32867	35047	37217	39378	41529	43670	45802	32
15	24089	26308	28516	30715	32904	35083	37253	39414	41564	43706	45838	33
30	24126	26345	28553	30751	32940	35120	37289	39449	41600	43741	45873	34
45	24164	26381	28590	30788	32977	35156	37325	39485	41636	43777	45909	35
9 0	24201	26418	28626	30824	33013	35192	37361	39521	41672	43813	45944	36
15	24238	26455	28663	30861	33049	35228	37397	39557	41707	43848	45980	37
30	24275	26492	28700	30898	33086	35265	37434	39593	41743	43884	46015	38
45	24312	26529	28736	30934	33122	35301	37470	39629	41779	43919	46050	39
10 0	24349	26566	28773	30971	33159	35337	37506	39665	41815	43955	46086	40
15	24386	26603	28810	31007	33195	35373	37542	39701	41850	43991	46121	41
30	24423	26639	28846	31044	33231	35409	37578	39737	41886	44026	46157	42
45	24460	26676	28883	31080	33268	35446	37614	39773	41922	44062	46192	43
11 0	24497	26713	28920	31117	33304	35482	37650	39808	41958	44097	46228	44
15	24534	26750	28957	31153	33341	35518	37686	39844	41993	44133	46263	45
30	24571	26787	28993	31190	33377	35554	37722	39880	42029	44169	46298	46
45	24608	26824	29030	31226	33413	35590	37758	39916	42065	44204	46334	47
12 0	24645	26861	29067	31263	33450	35627	37794	39952	42101	44240	46369	48
15	24682	26898	29103	31300	33486	35663	37830	39988	42136	44275	46405	49
30	24719	26934	29140	31336	33522	35699	37866	40024	42172	44311	46440	50
45	24756	26971	29177	31373	33559	35735	37902	40060	42208	44346	46476	51
13 0	24793	27008	29213	31409	33595	35771	37938	40096	42243	44382	46511	52
15	24830	27045	29250	31446	33631	35808	37974	40131	42279	44417	46546	53
30	24867	27082	29287	31482	33668	35844	38010	40167	42315	44453	46582	54
45	24904	27119	29323	31519	33704	35880	38046	40203	42351	44489	46617	55
14 0	24941	27155	29360	31555	33740	35916	38082	40239	42386	44524	46653	56
15	24978	27192	29397	31592	33777	35952	38118	40275	42422	44560	46688	57
30	25015	27229	29433	31628	33813	35988	38154	40311	42458	44595	46723	58
45	25052	27266	29470	31665	33849	36025	38190	40347	42493	44631	46759	59

	Sec.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
D 37.	Parts	2	5	7	10	12	15	17	20	22	25	27	29	32	34	37
D 35.	Parts	2	5	7	9	12	14	16	19	21	[illegible]	26	28	[illegible]	33	35

LOG. SINE SQUARE

	83°		84°				85°				86°	
	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	
	$5^h 34^m$	$5^h 35^m$	$5^h 36^m$	$5^h 37^m$	$5^h 38^m$	$5^h 39^m$	$5^h 40^m$	$5^h 41^m$	$5^h 42^m$	$5^h 43^m$	$5^h 44^m$	s.
′ ″	9·6	9·6	9·6	9·6	9·6	9·6	9·6	9·6	9·6	9·6	9·6	
0 0	46794	48913	51022	53122	55212	57294	59367	61430	63485	65530	67567	0
5	46829	48948	51057	53157	55247	57329	59401	61464	63519	65564	67601	1
30	46865	48983	51092	53192	55282	57363	59436	61499	63553	65598	67634	2
45	46900	49018	51127	53226	55317	57398	59470	61533	63587	65632	67668	3
1 0	46936	49053	51162	53261	55352	57433	59504	61567	63621	65666	67702	4
15	46971	49089	51197	53296	55386	57467	59539	61602	63655	65700	67736	5
30	47006	49124	51232	53331	55421	57502	59573	61636	63690	65734	67770	6
45	47042	49159	51267	53366	55456	57536	59608	61670	63724	65768	67804	7
2 0	47077	49194	51302	53401	55491	57571	59642	61705	63758	65802	67837	8
15	47113	49230	51337	53436	55525	57606	59677	61739	63792	65836	67871	9
30	47148	49265	51372	53471	55560	57640	59711	61773	63826	65870	67905	10
45	47183	49300	51407	53506	55595	57675	59746	61807	63860	65904	67939	11
3 0	47219	49335	51442	53541	55630	57709	59780	61842	63894	65938	67973	12
15	47254	49370	51478	53575	55664	57744	59815	61876	63929	65972	68007	13
30	47289	49406	51513	53610	55699	57779	59849	61910	63963	66006	68041	14
45	47325	49441	51548	53645	55734	57813	59883	61945	63997	66040	68074	15
4 0	47360	49476	51583	53680	55768	57848	59918	61979	64031	66074	68108	16
15	47395	49511	51618	53715	55803	57882	59952	62013	64065	66108	68142	17
30	47431	49546	51653	53750	55838	57917	59987	62047	64099	66142	68176	18
45	47466	49582	51688	53785	55873	57951	60021	62082	64133	66176	68210	19
5 0	47501	49617	51723	53820	55907	57986	60055	62116	64167	66210	68243	20
15	47537	49652	51758	53855	55942	58021	60090	62150	64201	66244	68277	21
30	47572	49687	51793	53889	55977	58055	60124	62184	64236	66278	68311	22
45	47607	49722	51828	53924	56012	58090	60159	62219	64270	66312	68345	23
6 0	47643	49757	51863	53959	56046	58124	60193	62253	64304	66346	68379	24
15	47678	49793	51898	53994	56081	58159	60228	62287	64338	66380	68413	25
30	47713	49828	51933	54029	56116	58193	60262	62321	64372	66414	68446	26
45	47749	49863	51968	54064	56150	58228	60296	62356	64406	66448	68480	27
7 0	47784	49898	52003	54099	56185	58262	60331	62390	64440	66482	68514	28
15	47819	49933	52038	54133	56220	58297	60365	62424	64474	66516	68548	29
30	47854	49968	52073	54168	56254	58332	60400	62458	64508	66550	68582	30
45	47890	50003	52108	54203	56289	58366	60434	62493	64543	66584	68615	31
8 0	47925	50039	52143	54238	56324	58401	60468	62527	64577	66617	68649	32
15	47960	50074	52178	54273	56359	58435	60503	62561	64611	66651	68683	33
30	47996	50109	52213	54308	56393	58470	60537	62595	64645	66685	68717	34
45	48031	50144	52248	54343	56428	58504	60571	62630	64679	66719	68751	35
9 0	48066	50179	52283	54377	56463	58539	60606	62664	64713	66753	68784	36
15	48102	50214	52318	54412	56497	58573	60640	62698	64747	66787	68818	37
30	48137	50249	52353	54447	56532	58608	60675	62732	64781	66821	68852	38
45	48172	50285	52388	54482	56567	58642	60709	62767	64815	66855	68886	39
10 0	48207	50320	52423	54517	56601	58677	60743	62801	64849	66889	68919	40
15	48243	50355	52458	54551	56636	58711	60778	62835	64883	66923	68953	41
30	48278	50390	52493	54586	56671	58746	60812	62869	64917	66957	68987	42
45	48313	50425	52528	54621	56705	58780	60846	62903	64951	66991	69021	43
11 0	48349	50460	52563	54656	56740	58815	60881	62938	64985	67024	69054	44
15	48384	50495	52598	54691	56775	58849	60915	62972	65020	67058	69088	45
30	48419	50530	52633	54725	56809	58884	60949	63006	65054	67092	69122	46
45	48454	50566	52668	54760	56844	58918	60984	63040	65088	67126	69156	47
12 0	48490	50601	52702	54795	56879	58953	61018	63074	65122	67160	69189	48
15	48525	50636	52737	54830	56913	58987	61053	63109	65156	67194	69223	49
30	48560	50671	52772	54865	56948	59022	61087	63143	65190	67228	69257	50
45	48595	50706	52807	54900	56982	59056	61121	63177	65224	67262	69291	51
13 0	48631	50741	52842	54934	57017	59091	61156	63211	65258	67296	69324	52
15	48666	50776	52877	54969	57052	59125	61190	63245	65292	67329	69358	53
30	48701	50811	52912	55004	57086	59160	61224	63280	65326	67363	69392	54
45	48736	50846	52947	55039	57121	59194	61259	63314	65360	67397	69426	55
14 0	48772	50881	52982	55073	57156	59229	61293	63348	65394	67431	69459	56
15	48807	50917	53017	55108	57190	59263	61327	63382	65428	67465	69493	57
30	48842	50952	53052	55143	57225	59298	61362	63416	65462	67499	69527	58
45	48877	50987	53087	55178	57260	59332	61396	63450	65496	67533	69561	59

Sec.	1	2	3″	4	5″	6″	7″	8″	9	10″	11	12	13	14	15″
D. 35. Parts	2	5	7	9	12	14	16	19	21	23	26	28	30	33	35

LOG. SINE SQUARE

	86°			87°				88°				
	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	
	5h 45m	5h 46m	5h 47m	5h 48m	5h 49m	5h 50m	5h 51m	5h 52m	5h 53m	5h 54m	5h 55m	s.
′ ″	9·6	9·6	9·6	9·6	9·6	9·6	9·6	9·6	9·6	9·6	9·6	
0 0	69594	71613	73623	75624	77617	79601	81576	83543	85501	87450	89391	0
15	69628	71647	73657	75658	77650	79634	81609	83575	85533	87482	89423	1
30	69662	71680	73690	75691	77683	79667	81642	83608	85566	87515	89456	2
45	69695	71714	73723	75724	77716	79700	81674	83641	85598	87547	89488	3
1 0	69729	71747	73757	75757	77749	79733	81707	83673	85631	87580	89520	4
15	69763	71781	73790	75791	77783	79766	81740	83706	85663	87612	89552	5
30	69797	71815	73824	75824	77816	79799	81773	83739	85696	87644	89585	6
45	69830	71848	73857	75857	77849	79832	81806	83771	85728	87677	89617	7
2 0	69864	71882	73890	75891	77882	79865	81839	83804	85761	87709	89649	8
15	69898	71915	73924	75924	77915	79898	81872	83837	85794	87742	89681	9
30	69931	71949	73957	75957	77948	79930	81904	83869	85826	87774	89714	10
45	69965	71982	73991	75990	77981	79963	81937	83902	85859	87806	89746	11
3 0	69999	72016	74024	76024	78014	79996	81970	83935	85891	87839	89778	12
15	70032	72049	74058	76057	78047	80029	82003	83967	85924	87871	89811	13
30	70066	72083	74091	76090	78081	80062	82036	84000	85956	87904	89843	14
45	70100	72116	74124	76123	78114	80095	82068	84033	85989	87936	89875	15
4 0	70133	72150	74158	76157	78147	80128	82101	84065	86021	87968	89907	16
15	70167	72184	74191	76190	78180	80161	82134	84098	86054	88001	89939	17
30	70201	72217	74224	76223	78213	80194	82167	84131	86086	88033	89972	18
45	70234	72251	74258	76256	78246	80227	82200	84163	86119	88066	90004	19
5 0	70268	72284	74291	76290	78279	80260	82232	84196	86151	88098	90036	20
15	70302	72318	74325	76323	78312	80293	82265	84229	86184	88130	90068	21
30	70336	72351	74358	76356	78345	80326	82298	84261	86216	88163	90101	22
45	70369	72385	74391	76389	78378	80359	82331	84294	86249	88195	90133	23
6 0	70403	72418	74425	76422	78411	80392	82364	84327	86281	88227	90165	24
15	70437	72452	74458	76456	78445	80425	82396	84359	86314	88260	90197	25
30	70470	72485	74491	76489	78478	80458	82429	84392	86346	88292	90230	26
45	70504	72519	74525	76522	78511	80491	82462	84425	86379	88325	90262	27
7 0	70538	72552	74558	76555	78544	80524	82495	84457	86411	88357	90294	28
15	70571	72586	74592	76589	78577	80557	82528	84490	86444	88389	90326	29
30	70605	72619	74625	76622	78610	80589	82560	84523	86476	88422	90358	30
45	70638	72653	74658	76655	78643	80622	82593	84555	86509	88454	90391	31
8 0	70672	72686	74692	76688	78676	80655	82626	84588	86541	88486	90423	32
15	70706	72720	74725	76721	78709	80688	82659	84620	86574	88519	90455	33
30	70739	72753	74758	76755	78742	80721	82691	84653	86606	88551	90487	34
45	70773	72787	74792	76788	78775	80754	82724	84686	86639	88583	90519	35
9 0	70807	72820	74825	76821	78808	80787	82757	84718	86671	88616	90552	36
15	70840	72854	74858	76854	78841	80820	82790	84751	86704	88648	90584	37
30	70874	72887	74892	76887	78874	80853	82822	84784	86736	88680	90616	38
45	70908	72921	74925	76920	78907	80886	82855	84816	86769	88713	90648	39
10 0	70941	72954	74958	76954	78940	80919	82888	84849	86801	88745	90680	40
15	70975	72988	74992	76987	78974	80951	82921	84881	86834	88777	90713	41
30	71008	73021	75025	77020	79007	80984	82953	84914	86866	88810	90745	42
45	71042	73054	75058	77053	79040	81017	82986	84947	86899	88842	90777	43
11 0	71076	73088	75092	77086	79073	81050	83019	84979	86931	88874	90809	44
15	71109	73121	75125	77120	79106	81083	83052	85012	86963	88907	90841	45
30	71143	73155	75158	77153	79139	81116	83084	85044	86996	88939	90873	46
45	71176	73188	75192	77186	79172	81149	83117	85077	87028	88971	90905	47
12 0	71210	73222	75225	77219	79205	81182	83150	85110	87061	89003	90938	48
15	71244	73255	75258	77252	79238	81214	83183	85142	87093	89036	90970	49
30	71277	73289	75291	77285	79271	81247	83215	85175	87126	89068	91002	50
45	71311	73322	75325	77319	79304	81280	83248	85207	87158	89100	91034	51
13 0	71344	73356	75358	77352	79337	81313	83281	85240	87191	89133	91066	52
15	71378	73389	75391	77385	79370	81346	83313	85273	87223	89165	91099	53
30	71412	73423	75425	77418	79403	81379	83346	85305	87255	89197	91131	54
45	71445	73456	75458	77451	79436	81412	83379	85338	87288	89230	91163	55
14 0	71479	73489	75491	77484	79469	81445	83412	85370	87320	89262	91195	56
15	71512	73523	75525	77518	79502	81477	83444	85403	87353	89294	91227	57
30	71546	73556	75558	77551	79535	81510	83477	85435	87385	89326	91259	58
45	71580	73590	75591	77584	79568	81543	83510	85468	87417	89359	91291	59

D. 33. Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
Parts	2	4	7	9	11	13	15	18	20	22	24	26	29	31	33

LOG. SINE SQUARE

	89°				90°				91°			
	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	
′ ″	5h 56m	5h 57m	5h 58m	5h 59m	6h 0m	6h 1m	6h 2m	6h 3m	6h 4m	6h 5m	6h 6m	s.
	9·6	9·6	9·6	9·6	9·	9·7	9·7	9·7	9·7	9·7	9·7	
0 0	91324	93248	95163	97071	698970	00861	02743	04618	06484	08342	10192	0
15	91356	93280	95195	97103	699002	00892	02775	04649	06515	08373	10223	1
30	91388	93312	95227	97134	699033	00924	02806	04680	06546	08404	10254	2
45	91420	93344	95259	97166	699065	00955	02837	04711	06577	08435	10285	3
1 0	91452	93376	95291	97198	699096	00987	02869	04742	06608	08466	10315	4
15	91484	93408	95323	97229	699128	01018	02900	04774	06639	08497	10346	5
30	91516	93440	95355	97261	699159	01049	02931	04805	06670	08528	10377	6
45	91548	93472	95386	97293	699191	01081	02963	04836	06701	08558	10408	7
2 0	91581	93504	95418	97325	699223	01112	02994	04867	06732	08589	10438	8
15	91613	93536	95450	97356	699254	01144	03025	04898	06763	08620	10469	9
30	91645	93568	95482	97388	699286	01175	03056	04929	06794	08651	10500	10
45	91677	93600	95514	97420	699317	01207	03088	04961	06825	08682	10531	11
3 0	91709	93632	95546	97451	699349	01238	03119	04992	06856	08713	10561	12
15	91741	93664	95577	97483	699380	01269	03150	05023	06887	08744	10592	13
30	91773	93695	95609	97515	699412	01301	03182	05054	06918	08775	10623	14
45	91805	93727	95641	97546	699443	01332	03213	05085	06949	08805	10653	15
4 0	91838	93759	95673	97578	699475	01364	03244	05116	06980	08836	10684	16
15	91870	93791	95705	97610	699506	01395	03275	05147	07011	08867	10715	17
30	91902	93823	95737	97641	699538	01426	03307	05179	07042	08898	10746	18
45	91933	93855	95768	97673	699570	01458	03338	05210	07073	08929	10776	19
5 0	91966	93887	95800	97705	699601	01489	03369	05241	07104	08960	10807	20
15	91998	93919	95832	97737	699633	01521	03400	05272	07135	08991	10838	21
30	92030	93951	95864	97768	699664	01552	03432	05303	07166	09021	10869	22
45	92062	93983	95896	97800	699696	01583	03463	05334	07197	09052	10899	23
6 0	92094	94015	95927	97831	699727	01615	03494	05365	07228	09083	10930	24
15	92126	94047	95959	97863	699759	01646	03525	05396	07259	09114	10961	25
30	92158	94079	95991	97895	699790	01678	03557	05428	07290	09145	10991	26
45	92190	94111	96023	97926	699822	01709	03588	05459	07321	09176	11022	27
7 0	92223	94143	96055	97958	699853	01740	03619	05490	07352	09207	11053	28
15	92255	94175	96086	97990	699885	01772	03650	05521	07383	09237	11083	29
30	92287	94207	96118	98021	699916	01803	03682	05552	07414	09268	11114	30
45	92319	94239	96150	98053	699948	01834	03713	05583	07445	09299	11145	31
8 0	92351	94270	96182	98085	699979	01866	03744	05614	07476	09330	11176	32
15	92383	94302	96214	98116	700011	01897	03775	05645	07507	09361	11206	33
30	92415	94334	96245	98148	700042	01929	03807	05676	07538	09392	11237	34
45	92447	94366	96277	98180	700074	01960	03838	05707	07569	09422	11268	35
9 0	92479	94398	96309	98211	700105	01991	03869	05739	07600	09453	11298	36
15	92511	94430	96341	98243	700137	02023	03900	05770	07631	09484	11329	37
30	92543	94462	96372	98275	700168	02054	03932	05801	07662	09515	11360	38
45	92575	94494	96404	98306	700200	02085	03963	05832	07693	09546	11390	39
10 0	92607	94526	96436	98338	700231	02117	03994	05863	07724	09576	11421	40
15	92639	94558	96468	98370	700263	02148	04025	05894	07755	09607	11452	41
30	92671	94590	96499	98401	700294	02179	04056	05925	07786	09638	11482	42
45	92703	94621	96531	98433	700326	02211	04088	05956	07817	09669	11513	43
11 0	92735	94653	96563	98464	700357	02242	04119	05987	07847	09700	11544	44
15	92767	94685	96595	98496	700389	02274	04150	06018	07878	09730	11574	45
30	92800	94717	96627	98528	700420	02305	04181	06049	07909	09761	11605	46
45	92832	94749	96658	98559	700452	02336	04212	06080	07940	09792	11636	47
12 0	92864	94781	96690	98591	700483	02368	04244	06112	07971	09823	11666	48
15	92896	94813	96722	98622	700515	02399	04275	06143	08002	09854	11697	49
30	92928	94845	96754	98654	700546	02430	04306	06174	08033	09884	11728	50
45	92960	94877	96785	98686	700578	02462	04337	06205	08064	09915	11758	51
13 0	92992	94909	96817	98717	700609	02493	04368	06236	08095	09946	11789	52
15	93024	94940	96849	98749	700641	02524	04400	06267	08126	09977	11820	53
30	93056	94972	96881	98780	700672	02556	04431	06298	08157	10008	11850	54
45	93088	95004	96912	98812	700702	02587	04462	06329	08188	10038	11881	55
14 0	93120	95036	96944	98844	700735	02618	04493	06360	08219	10069	11912	56
15	93152	95068	96976	98875	700766	02649	04524	06391	08249	10100	11942	57
30	93184	95100	97007	98907	700798	02681	04556	06422	08280	10131	11973	58
45	93216	95132	97039	98938	700829	02712	04587	06453	08311	10161	12004	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 32.	Parts	2	4	6	9	11	13	15	17	19	21	23	26	28	30	32

LOG. SINE SQUARE

	91°	92°				93°				94°		
	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	
	6h 7m	6h 8m	6h 9m	6h 10m	6h 11m	6h 12m	6h 13m	6h 14m	6h 15m	6h 16m	6h 17m	s.
′ ″	9·7	9·7	9·7	9·7	9·7	9·7	9·7	9·7	9·7	9·7	9·7	
0 0	12034	13868	15694	17512	19322	21124	22919	24705	26484	28255	30018	0
15	12065	13899	15725	17542	19352	21154	22949	24735	26514	28284	30047	1
30	12095	13929	15755	17573	19382	21184	22978	24765	26543	28314	30077	2
45	12126	13960	15785	17603	19412	21214	23008	24794	26573	28343	30106	3
1 0	12157	13990	15816	17633	19443	21244	23038	24824	26602	28373	30135	4
15	12187	14021	15846	17663	19473	21274	23068	24854	26632	28402	30165	5
30	12218	14051	15876	17693	19503	21304	23098	24883	26661	28432	30194	6
45	12249	14082	15907	17724	19533	21334	23128	24913	26691	28461	30223	7
2 0	12279	14112	15937	17754	19563	21364	23157	24943	26721	28490	30253	8
15	12310	14142	15967	17784	19593	21394	23187	24973	26750	28520	30282	9
30	12340	14173	15998	17814	19623	21424	23217	25002	26780	28549	30311	10
45	12371	14203	16028	17845	19653	21454	23247	25032	26809	28579	30341	11
3 0	12402	14234	16058	17875	19683	21484	23277	25062	26839	28608	30370	12
15	12432	14264	16089	17905	19713	21514	23306	25091	26868	28638	30399	13
30	12463	14295	16119	17935	19743	21544	23336	25121	26898	28667	30428	14
45	12493	14325	16149	17965	19773	21574	23366	25151	26927	28696	30458	15
4 0	12524	14356	16180	17996	19804	21604	23396	25180	26957	28726	30487	16
15	12555	14386	16210	18026	19834	21634	23426	25210	26987	28755	30516	17
30	12585	14417	16240	18056	19864	21664	23455	25240	27016	28785	30546	18
45	12616	14447	16271	18086	19894	21693	23485	25270	27046	28814	30575	19
5 0	12646	14478	16301	18116	19924	21723	23515	25299	27075	28843	30604	20
15	12677	14508	16331	18147	19954	21753	23545	25329	27105	28873	30633	21
30	12708	14539	16362	18177	19984	21783	23575	25358	27134	28902	30663	22
45	12738	14569	16392	18207	20014	21813	23604	25388	27164	28932	30692	23
6 0	12769	14599	16422	18237	20044	21843	23634	25418	27193	28961	30721	24
15	12799	14630	16453	18267	20074	21873	23664	25447	27223	28990	30751	25
30	12830	14660	16483	18297	20104	21903	23694	25477	27252	29020	30780	26
45	12860	14691	16513	18328	20134	21933	23724	25507	27282	29049	30809	27
7 0	12891	14721	16544	18358	20164	21963	23753	25536	27311	29079	30838	28
15	12922	14752	16574	18388	20194	21993	23783	25566	27341	29108	30868	29
30	12952	14782	16604	18418	20224	22023	23813	25596	27370	29137	30897	30
45	12983	14813	16634	18448	20254	22052	23843	25625	27400	29167	30926	31
8 0	13013	14843	16665	18479	20284	22082	23872	25655	27429	29196	30955	32
15	13044	14873	16695	18509	20314	22112	23902	25685	27459	29226	30985	33
30	13074	14904	16725	18539	20344	22142	23932	25714	27488	29255	31014	34
45	13105	14934	16756	18569	20374	22172	23962	25744	27518	29284	31043	35
9 0	13136	14965	16786	18599	20405	22202	23992	25773	27547	29314	31072	36
15	13166	14995	16816	18629	20435	22232	24021	25803	27577	29343	31102	37
30	13197	15026	16846	18659	20465	22262	24051	25833	27606	29373	31131	38
45	13227	15056	16877	18690	20495	22292	24081	25862	27636	29402	31160	39
10 0	13258	15086	16907	18720	20525	22322	24111	25892	27665	29431	31189	40
15	13288	15117	16937	18750	20555	22351	24140	25922	27695	29461	31219	41
30	13319	15147	16967	18780	20585	22381	24170	25951	27724	29490	31248	42
45	13349	15178	16998	18810	20615	22411	24200	25981	27754	29519	31277	43
11 0	13380	15208	17028	18840	20645	22441	24230	26010	27783	29549	31306	44
15	13411	15238	17058	18870	20675	22471	24259	26040	27813	29578	31335	45
30	13441	15269	17089	18901	20705	22501	24289	26070	27842	29607	31365	46
45	13472	15299	11719	18931	20735	22531	24319	26099	27872	29637	31394	47
12 0	13502	15330	17149	18961	20765	22560	24349	26129	27901	29666	31423	48
15	13533	15360	17179	18991	20795	22590	24378	26158	27931	29695	31452	49
30	13563	15390	17210	19021	20825	22620	24408	26188	27960	29725	31482	50
45	13594	15421	17240	19051	20855	22650	24438	26218	27990	29754	31511	51
13 0	13624	15451	17270	19081	20885	22680	24468	26247	28019	29783	31540	52
15	13655	15481	17300	19111	20915	22710	24497	[illegible]	28049	29813	31569	53
30	13685	15512	17331	19141	20945	22740	24527	26306	28078	29842	31598	54
45	13716	15542	17361	19172	20975	22769	24557	26336	28108	29871	31628	55
14 0	13746	15573	17391	19202	21004	22799	24586	26366	28137	29901	31657	56
15	13777	15603	17421	19232	21034	22829	24616	26395	28166	29930	31686	57
30	13807	15633	17452	19262	21064	22859	24646	26425	28196	29959	31715	58
45	13833	15664	17482	19292	21094	22889	24676	26454	28225	29989	31744	59

D 30. Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
Parts	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30

LOG. SINE SQUARE

	94°		95°				96°				97°	
	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	
	6h 18m	6h 19m	6h 20m	6h 21m	6h 22m	6h 23m	6h 24m	6h 25m	6h 26m	6h 27m	6h 28m	s.
′ ″	9·7	9·7	9·7	9·7	9·7	9·7	9·7	9·7	9·7	9·7	9·7	
0 0	31774	33521	35262	36994	38719	40437	42147	43849	45544	47232	48912	0
15	31803	33551	35291	37023	38748	40465	42175	43878	45573	47260	48940	1
30	31832	33580	35320	37052	38777	40494	42204	43906	45601	47288	48968	2
45	31861	33609	35349	37081	38805	40523	42232	43934	45629	47316	48996	3
1 0	31890	33638	35377	37110	38834	40551	42261	43963	45657	47344	49024	4
15	31920	33667	35406	37138	38863	40580	42289	43991	45685	47372	49052	5
30	31949	33696	35435	37167	38892	40608	42317	44019	45713	47400	49080	6
45	31978	33725	35464	37196	38920	40637	42346	44048	45742	47428	49108	7
2 0	32007	33754	35493	37225	38949	40665	42374	44076	45770	47456	49136	8
15	32036	33783	35522	37254	38978	40694	42403	44104	45798	47485	49164	9
30	32066	33812	35551	37282	39006	40722	42431	44132	45826	47513	49192	10
45	32095	33841	35580	37311	39035	40751	42460	44161	45854	47541	49219	11
3 0	32124	33870	35609	37340	39063	40780	42488	44189	45883	47569	49247	12
15	32153	33899	35638	37369	39092	40808	42516	44217	45911	47597	49275	13
30	32182	33928	35667	37397	39121	40837	42545	44246	45939	47625	49303	14
45	32211	33957	35696	37426	39149	40865	42573	44274	45967	47653	49331	15
4 0	32241	33986	35724	37455	39178	40894	42602	44302	45995	47681	49359	16
15	32270	34015	35753	37484	39207	40922	42630	44330	46023	47709	49387	17
30	32299	34044	35782	37513	39235	40951	42658	44359	46051	47737	49415	18
45	32328	34073	35811	37541	39264	40979	42687	44387	46080	47765	49443	19
5 0	32357	34102	35840	37570	39293	41008	42715	44415	46108	47793	49471	20
15	32386	34131	35869	37599	39321	41036	42744	44443	46136	47821	49499	21
30	32415	34160	35898	37628	39350	41065	42772	44472	46164	47849	49526	22
45	32445	34189	35927	37656	39379	41093	42800	44500	46192	47877	49554	23
6 0	32474	34218	35956	37685	39407	41122	42829	44528	46220	47905	49582	24
15	32503	34248	35985	37714	39436	41150	42857	44557	46249	47933	49610	25
30	32532	34277	36013	37743	39465	41179	42885	44585	46277	47961	49638	26
45	32561	34306	36042	37772	39493	41207	42914	44613	46305	47989	49666	27
7 0	32590	34335	36071	37800	39522	41236	42942	44641	46333	48017	49694	28
15	32619	34364	36100	37829	39551	41264	42971	44670	46361	48045	49722	29
30	32649	34394	36129	37858	39579	41293	42999	44698	46389	48073	49750	30
45	32678	34422	36158	37887	39608	41321	43027	44726	46417	48101	49778	31
8 0	32707	34451	36187	37915	39636	41350	43056	44754	46445	48129	49805	32
15	32736	34479	36216	37944	39665	41378	43084	44783	46473	48157	49833	33
30	32765	34509	36244	37973	39694	41407	43112	44811	46502	48185	49861	34
45	32794	34537	36273	38002	39722	41435	43141	44839	46530	48213	49889	35
9 0	32823	34567	36302	38030	39751	41464	43169	44867	46558	48241	49917	36
15	32852	34590	36331	38059	39779	41492	43198	44896	46586	48269	49945	37
30	32882	34625	36360	38088	39808	41521	43226	44924	46614	48297	49973	38
45	32911	34654	36389	38117	39837	41549	43254	44952	46642	48325	50000	39
10 0	32940	34682	36418	38145	39865	41578	43283	44980	46670	48353	50028	40
15	32969	34711	36447	38174	39894	41606	43311	45009	46698	48381	50056	41
30	32998	34740	36475	38203	39922	41635	43339	45037	46727	48409	50084	42
45	33027	34769	36504	38231	39951	41663	43368	45065	46755	48437	50112	43
11 0	33056	34798	36533	38260	39980	41692	43396	45093	46783	48465	50140	44
15	33085	34827	36562	38289	40008	41720	43424	45121	46811	48493	50168	45
30	33114	34856	36591	38318	40037	41749	43453	45150	46839	48521	50195	46
45	33143	34885	36620	38346	40065	41777	43481	45178	46867	48549	50223	47
12 0	33173	34914	36648	38375	40094	41805	43509	45206	46895	48577	50251	48
15	33202	34943	36677	38404	40123	41834	43538	45234	46923	48605	50279	49
30	33231	34972	36706	38432	40151	41862	43566	45262	46951	48633	50307	50
45	33260	35001	36735	38461	40180	41891	43594	45291	46979	48661	50335	51
13 0	33289	35030	36764	38490	40208	41919	43623	45319	47007	48689	50362	52
15	33318	35059	36793	38519	40237	41948	43651	45347	47036	48717	50390	53
30	33347	35088	36821	38547	40266	41976	43679	45375	47064	48745	50418	54
45	33376	35117	36850	38576	40294	42005	43708	45403	47093	48773	50446	55
14 0	33405	35146	36879	38605	40323	42033	43736	45432	47120	48800	50474	56
15	33434	35175	36908	38633	40351	42062	43764	45460	47148	48828	50502	57
30	33463	35204	36937	38662	40380	42090	43793	45488	47176	48856	50529	58
45	33492	35233	36966	38691	40408	42118	43821	45516	47204	48884	50557	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 28.	Parts	2	4	6	7	9	11	13	15	17	19	20	22	24	26	28

LOG. SINE SQUARE

	97°			98°				99°				
	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	
′ ″	6h 29m	6h 30m	6h 31m	6h 32m	6h 33m	6h 34m	6h 35m	6h 36m	6h 37m	6h 38m	6h 39m	s.
	9·7	9·7	9·7	9·7	9·7	9·7	9·7	9·7	9·7	9·7	9·7	
0 0	50585	52251	53909	55560	57203	58840	60469	62091	63706	65314	66914	0
15	50613	52278	53936	55587	57231	58867	60496	62118	63733	65340	66941	1
30	50641	52306	53964	55615	57258	58894	60523	62145	63760	65367	66968	2
45	50669	52334	53991	55642	57285	58921	60550	62172	63786	65394	66994	3
1 0	50696	52361	54019	55670	57313	58949	60577	62199	63813	65421	67021	4
15	50724	52389	54047	55697	57340	58976	60604	62226	63840	65447	67047	5
30	50752	52417	54074	55724	57367	59003	60631	62253	63867	65474	67074	6
45	50780	52444	54102	55752	57395	59030	60659	62280	63894	65501	67101	7
2 0	50808	52472	54129	55779	57422	59057	60686	62307	63921	65527	67127	8
15	50835	52500	54157	55807	57449	59085	60713	62334	63948	65554	67154	9
30	50863	52527	54184	55834	57477	59112	60740	62361	63974	65581	67180	10
45	50891	52555	54212	55862	57504	59139	60767	62388	64001	65608	67207	11
3 0	50919	52583	54240	55889	57531	59166	60794	62415	64028	65634	67234	12
15	50947	52611	54267	55916	57558	59193	60821	62442	64055	65661	67260	13
30	50974	52638	54295	55944	57586	59221	60848	62468	64082	65688	67287	14
45	51002	52666	54322	55971	57613	59248	60875	62495	64108	65714	67313	15
4 0	51030	52694	54350	55999	57640	59275	60902	62522	64135	65741	67340	16
15	51058	52721	54377	56026	57668	59302	60929	62549	64162	65768	67367	17
30	51085	52749	54405	56054	57695	59329	60956	62576	64189	65795	67393	18
45	51113	52776	54432	56081	57722	59356	60983	62603	64216	65821	67420	19
5 0	51141	52804	54460	56108	57750	59384	61010	62630	64243	65848	67446	20
15	51169	52832	54487	56136	57777	59411	61038	62657	64269	65875	67473	21
30	51197	52859	54515	56163	57804	59438	61065	62684	64296	65901	67499	22
45	51224	52887	54543	56191	57831	59465	61092	62711	64323	65928	67526	23
6 0	51252	52915	54570	56218	57859	59492	61119	62738	64350	65955	67553	24
15	51280	52942	54598	56245	57886	59519	61146	62765	64377	65981	67579	25
30	51308	52970	54625	56273	57913	59547	61173	62792	64403	66008	67606	26
45	51335	52998	54653	56300	57941	59574	61200	62819	64430	66035	67632	27
7 0	51363	53025	54680	56328	57968	59601	61227	62845	64457	66061	67659	28
15	51391	53053	54708	56355	57995	59628	61254	62872	64484	66088	67685	29
30	51419	53081	54735	56382	58022	59655	61281	62899	64511	66115	67712	30
45	51447	53108	54763	56410	58050	59682	61308	62926	64537	66141	67739	31
8 0	51474	53136	54790	56437	58077	59710	61335	62953	64564	66168	67765	32
15	51502	53164	54818	56465	58104	59737	61362	62980	64591	66195	67792	33
30	51530	53191	54845	56492	58131	59764	61389	63007	64618	66221	67818	34
45	51558	53219	54873	56519	58159	59791	61416	63034	64645	66248	67845	35
9 0	51585	53246	54900	56547	58186	59818	61443	63061	64671	66275	67871	36
15	51613	53274	54928	56574	58213	59845	61470	63088	64698	66302	67898	37
30	51641	53302	54955	56602	58241	59872	61497	63115	64725	66328	67924	38
45	51669	53329	54983	56629	58268	59900	61524	63141	64752	66355	67951	39
10 0	51696	53357	55010	56656	58295	59927	61551	63168	64778	66382	67977	40
15	51724	53385	55038	56684	58322	59954	61578	63195	64805	66408	68004	41
30	51752	53412	55065	56711	58350	59981	61605	63222	64832	66435	68031	42
45	51779	53440	55093	56738	58377	60008	61632	63249	64859	66462	68057	43
11 0	51807	53467	55120	56766	58404	60035	61659	63276	64886	66488	68084	44
15	51835	53495	55148	56793	58431	60062	61686	63303	64912	66515	68110	45
30	51863	53523	55175	56820	58459	60089	61713	63330	64939	66541	68137	46
45	51890	53550	55203	56848	58486	60117	61740	63357	64966	66568	68163	47
12 0	51918	53578	55230	56875	58513	60144	61767	63384	64993	66595	68190	48
15	51946	53605	55258	56903	58540	60171	61794	63410	65019	66621	68216	49
30	51974	53633	55285	56930	58568	60198	61821	63437	65046	66648	68243	50
45	52001	53661	55312	56957	58595	60225	61848	63464	65073	66675	68269	51
13 0	52029	53688	55340	56985	58622	60252	61875	63491	65100	66701	68296	52
15	52057	53716	55367	57012	58649	60279	61902	63518	65126	66728	68322	53
30	52084	53743	55395	57039	58676	60306	61929	63545	65153	66755	68349	54
45	52112	53771	55422	57067	58704	60333	61956	63572	65180	66781	68375	55
14 0	52140	53799	55450	57094	58731	60361	61983	63598	65207	66808	68402	56
15	52167	53826	55477	57121	58758	60388	62010	63625	65233	66834	68428	57
30	52195	53854	55505	57149	58785	60415	62037	63652	65260	66861	68455	58
45	52223	53881	55532	57176	58813	60442	62064	63679	65287	66888	68481	59

		1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 27.	Sec. / Parts	2	4	5	7	9	11	13	14	16	18	20	22	23	25	27

LOG. SINE SQUARE

	100°				101°				102°			
	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	
	6h 40m	6h 41m	6h 42m	6h 43m	6h 44m	6h 45m	6h 46m	6h 47m	6h 48m	6h 49m	6h 50m	s
′ ″	9·7	9·7	9·7	9·7	9·7	9·7	9·7	9·7	9·7	9·7	9·7	
0 0	68508	70094	71674	73246	74812	76371	77922	79467	81005	82536	84061	0
15	68534	70121	71700	73273	74838	76397	77948	79493	81031	82562	84086	1
30	68561	70147	71726	73299	74864	76423	77974	79519	81056	82587	84111	2
45	68587	70174	71753	73325	74890	76448	78000	79544	81082	82613	84137	3
1 0	68614	70200	71779	73351	74916	76474	78026	79570	81107	82638	84162	4
15	68640	70226	71805	73377	74942	76500	78051	79596	81133	82664	84187	5
30	68667	70253	71832	73403	74968	76526	78077	79621	81159	82689	84212	6
45	68693	70279	71858	73430	74994	76552	78103	79647	81184	82714	84238	7
2 0	68720	70305	71884	73456	75020	76578	78129	79673	81210	82740	84263	8
15	68746	70332	71910	73482	75046	76604	78155	79698	81235	82765	84289	9
30	68773	70358	71936	73508	75072	76630	78180	79724	81261	82791	84314	10
45	68799	70385	71963	73534	75098	76656	78206	79750	81286	82816	84339	11
3 0	68826	70411	71989	73560	75124	76682	78232	79775	81312	82842	84365	12
15	68852	70437	72015	73586	75150	76707	78258	79801	81338	82867	84390	13
30	68879	70464	72042	73612	75176	76733	78284	79827	81363	82893	84415	14
45	68905	70490	72068	73639	75202	76759	78309	79852	81389	82918	84441	15
4 0	68932	70516	72094	73665	75228	76785	78335	79878	81414	82943	84466	16
15	68958	70543	72120	73691	75254	76811	78361	79904	81440	82969	84491	17
30	68985	70569	72146	73717	75280	76837	78387	79929	81465	82994	84516	18
45	69011	70595	72173	73743	75306	76863	78412	79955	81491	83020	84542	19
5 0	69038	70622	72199	73769	75332	76889	78438	79981	81516	83045	84567	20
15	69064	70648	72225	73795	75358	76915	78464	80006	81542	83071	84592	21
30	69090	70674	72251	73821	75384	76940	78490	80032	81567	83096	84618	22
45	69117	70701	72278	73847	75410	76966	78515	80058	81593	83121	84643	23
6 0	69143	70727	72304	73874	75436	76992	78541	80083	81618	83147	84668	24
15	69170	70753	72330	73900	75462	77018	78567	80109	81644	83172	84694	25
30	69196	70780	72356	73926	75488	77044	78593	80134	81669	83198	84719	26
45	69223	70806	72382	73952	75514	77070	78618	80160	81695	83223	84744	27
7 0	69249	70832	72409	73978	75540	77096	78644	80186	81721	83248	84770	28
15	69276	70859	72435	74004	75566	77122	78670	80211	81746	83274	84795	29
30	69302	70885	72461	74030	75592	77147	78696	80237	81772	83299	84820	30
45	69329	70911	72487	74056	75618	77173	78721	80263	81797	83325	84845	31
8 0	69355	70938	72514	74082	75644	77199	78747	80288	81823	83350	84871	32
15	69381	70964	72540	74108	75670	77225	78773	80314	81848	83375	84896	33
30	69408	70990	72566	74135	75696	77251	78799	80340	81874	83401	84921	34
45	69434	71017	72592	74161	75722	77277	78824	80365	81899	83426	84947	35
9 0	69461	71043	72618	74187	75748	77303	78850	80391	81925	83452	84972	36
15	69487	71069	72645	74213	75774	77328	78876	80416	81950	83477	84997	37
30	69514	71096	72671	74239	75800	77354	78902	80442	81976	83502	85022	38
45	69540	71122	72697	74265	75826	77380	78927	80468	82001	83528	85048	39
10 0	69566	71148	72723	74291	75852	77406	78953	80493	82027	83553	85073	40
15	69593	71175	72749	74317	75878	77432	78979	80519	82052	83579	85098	41
30	69619	71201	72775	74343	75904	77458	79005	80544	82078	83604	85123	42
45	69646	71227	72802	74369	75930	77483	79030	80570	82103	83629	85149	43
11 0	69672	71253	72828	74395	75956	77509	79056	80596	82129	83655	85174	44
15	69698	71280	72854	74421	75982	77535	79082	80621	82154	83680	85199	45
30	69725	71306	72880	74447	76008	77561	79107	80647	82180	83705	85224	46
45	69751	71332	72906	74473	76034	77587	79133	80672	82205	83731	85250	47
12 0	69778	71359	72933	74500	76060	77613	79159	80698	82231	83756	85275	48
15	69804	71385	72959	74526	76085	77638	79184	80724	82256	83782	85300	49
30	69831	71411	72985	74552	76111	77664	79210	80749	82282	83807	85326	50
45	69857	71437	73011	74578	76137	77690	79236	80775	82307	83832	85351	51
13 0	69883	71464	73037	74604	76163	77716	79262	80799	82333	83858	85376	52
15	69910	71490	73063	74630	76189	77742	79287	80826	82358	83883	85401	53
30	69936	71516	73090	74656	76215	77768	79313	80852	82384	83908	85427	54
45	69962	71543	73116	74682	76241	77793	79339	80877	82409	83934	85452	55
14 0	69989	71569	73142	74708	76267	77819	79364	80903	82434	83959	85477	56
15	70015	71595	73168	74734	76293	77845	79390	80928	82460	83985	85502	57
30	70042	71621	73194	74760	76319	77871	79416	80954	82485	84010	85528	58
45	70068	71648	73220	74786	76345	77897	79442	80980	82511	84035	85553	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 26.	Parts	2	3	5	7	9	10	12	14	15	17	19	21	22	24	26

LOG. SINE SQUARE

m s	102°	103°				104°				105°		s.
	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	
	6h 51m	6h 52m	6h 53m	6h 54m	6h 55m	6h 56m	6h 57m	6h 58m	6h 59m	7h 0m	7h 1m	s.
	9·7	9·7	9·7	9·7	9·7	9·7	9·7	9·7	9·7	9·	9·8	
0′ 0″	85578	87089	88593	90090	91580	93064	94541	96012	97476	798933	00384	0
15	85603	87114	88618	90115	91605	93089	94566	96036	97500	798958	00408	1
30	85628	87139	88643	90140	91630	93114	94591	96061	97525	798982	00432	2
45	85654	87164	88668	90165	91655	93138	94615	96085	97549	799006	00456	3
1 0	85679	87189	88693	90189	91680	93163	94640	96110	97573	799030	00481	4
15	85704	87214	88718	90214	91704	93188	94664	96134	97598	799054	00505	5
30	85729	87239	88743	90239	91729	93212	94689	96159	97622	799079	00529	6
45	85755	87265	88768	90264	91754	93237	94713	96183	97646	799103	00553	7
2 0	85780	87290	88793	90289	91779	93262	94738	96208	97671	799127	00577	8
15	85805	87315	88818	90314	91803	93286	94762	96232	97695	799151	00601	9
30	85830	87340	88843	90339	91828	93311	94787	96256	97719	799176	00625	10
45	85855	87365	88868	90364	91853	93336	94812	96281	97744	799200	00649	11
3 0	85881	87390	88893	90389	91878	93360	94836	96305	97768	799224	00673	12
15	85906	87415	88918	90413	91902	93385	94861	96330	97792	799248	00698	13
30	85931	87440	88943	90438	91927	93410	94885	96354	97817	799272	00722	14
45	85956	87465	88968	90463	91952	93434	94910	96379	97841	799297	00746	15
4 0	85982	87490	88993	90488	91977	93459	94934	96403	97865	799321	00770	16
15	86007	87516	89018	90513	92002	93483	94959	96427	97889	799345	00794	17
30	86032	87541	89043	90538	92026	93508	94983	96452	97914	799369	00818	18
45	86057	87566	89068	90563	92051	93533	95008	96476	97938	799393	00842	19
5 0	86082	87591	89093	90587	92076	93557	95032	96501	97962	799418	00866	20
15	86108	87616	89117	90612	92101	93582	95057	96525	97987	799442	00890	21
30	86133	87641	89142	90637	92125	93607	95081	96549	98011	799466	00914	22
45	86158	87666	89167	90662	92150	93631	95106	96574	98035	799490	00938	23
6 0	86183	87691	89192	90687	92175	93656	95130	96598	98060	799514	00963	24
15	86208	87716	89217	90712	92200	93681	95155	96623	98084	799539	00987	25
30	86233	87741	89242	90737	92224	93705	95180	96647	98108	799563	01011	26
45	86259	87766	89267	90761	92249	93730	95204	96672	98133	799587	01035	27
7 0	86284	87791	89292	90786	92274	93754	95229	96696	98157	799611	01059	28
15	86309	87816	89317	90811	92299	93779	95253	96720	98181	799635	01083	29
30	86334	87842	89342	90836	92323	93804	95278	96745	98205	799660	01107	30
45	86359	87866	89367	90861	92348	93828	95302	96769	98230	799684	01131	31
8 0	86385	87892	89392	90886	92373	93853	95327	96794	98254	799708	01155	32
15	86410	87917	89417	90911	92397	93878	95351	96818	98278	799732	01179	33
30	86435	87942	89442	90935	92422	93902	95376	96842	98303	799756	01203	34
45	86460	87967	89467	90960	92447	93927	95400	96867	98327	799780	01227	35
9 0	86485	87992	89491	90985	92472	93951	95425	96891	98351	799805	01251	36
15	86510	88017	89517	91010	92496	93976	95449	96916	98375	799829	01275	37
30	86536	88042	89542	91035	92521	94001	95474	96940	98400	799853	01299	38
45	86561	88067	89567	91060	92546	94025	95498	96964	98424	799877	01324	39
10 0	86586	88092	89592	91084	92570	94050	95523	96989	98448	799901	01348	40
15	86611	88117	89617	91109	92595	94074	95547	97013	98473	799925	01372	41
30	86636	88142	89642	91134	92620	94099	95572	97038	98497	799949	01396	42
45	86661	88167	89666	91159	92644	94124	95596	97062	98521	799974	01420	43
11 0	86687	88192	89691	91184	92669	94148	95620	97086	98545	799998	01444	44
15	86712	88217	89716	91208	92694	94173	95645	97111	98570	800022	01468	45
30	86737	88242	89741	91233	92719	94197	95669	97135	98594	800046	01492	46
45	86762	88267	89766	91258	92743	94222	95694	97159	98618	800070	01516	47
12 0	86787	88292	89791	91283	92768	94247	95718	9 184	98642	800094	01540	48
15	86812	88317	89816	91308	92793	94271	95743	97208	98667	800119	01564	49
30	86837	88342	89841	91333	92817	94296	95767	97232	98691	800143	01588	50
45	86863	88368	89866	91357	92842	94320	95792	97257	98715	800167	01612	51
13 0	86888	88393	89891	91382	92867	94345	95816	97281	98739	800191	01636	52
15	86913	88418	89916	91407	92891	94369	95841	97306	98764	800215	01660	53
30	86938	88443	89940	91432	92916	94394	95865	97330	98788	800239	01684	54
45	86963	88468	89965	91457	92941	94419	95890	97354	98812	800264	01708	55
14 0	86988	88493	89990	91481	92966	94443	95914	97379	98836	800288	01732	56
15	87013	88518	90015	91506	92990	94468	95939	97403	98861	800312	01756	57
30	87038	88543	90040	91531	93015	94492	95963	97427	98885	800336	01780	58
45	87064	88568	90065	91556	93040	94517	95988	97452	98909	800360	01804	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 25.	Parts	2	3	5	7	8	10	12	13	15	17	18	20	22	23	25

LOG. SINE SQUARE

	105°		106°				107°				108°		
	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	
	7h 2m	7h 3m	7h 4m	7h 5m	7h 6m	7h 7m	7h 8m	7h 9m	7h 10m	7h 11m	7h 12m	7h 13m	s.
′ ″	9·80	9·80	9·80	9·80	9·80	9·8	9·8	9·8	9·8	9·8	9·8	9·8	
0 0	1828	3266	4697	6122	7540	08952	10357	11756	13149	14535	15915	17289	0
15	1852	3290	4721	6146	7564	08975	10381	11780	13172	14558	15938	17312	1
30	1876	3314	4745	6169	7587	08999	10404	11803	13195	14581	15961	17335	2
45	1900	3338	4769	6193	7611	09022	10427	11826	13219	14604	15984	17357	3
1 0	1924	3362	4792	6217	7634	09046	10451	11849	13242	14628	16007	17380	4
15	1948	3385	4816	6240	7658	09069	10474	11873	13265	14651	16030	17403	5
30	1972	3409	4840	6264	7682	09093	10498	11896	13288	14674	16054	17426	6
45	1996	3433	4864	6288	7705	09116	10521	11919	13311	14697	16077	17449	7
2 0	2020	3457	4887	6311	7729	09140	10544	11942	13334	14720	16100	17472	8
15	2044	3481	4911	6335	7752	09163	10568	11966	13357	14743	16123	17494	9
30	2068	3505	4935	6359	7776	09187	10591	11989	13381	14766	16146	17517	10
45	2092	3529	4959	6383	7800	09210	10614	12012	13404	14789	16169	17540	11
3 0	2116	3553	4983	6406	7823	09234	10638	12035	13427	14812	16191	17563	12
15	2140	3577	5006	6430	7847	09257	10661	12059	13450	14835	16214	17586	13
30	2164	3601	5030	6453	7870	09281	10684	12082	13473	14858	16237	17608	14
45	2188	3624	5054	6477	7894	09304	10708	12105	13496	14881	16260	17631	15
4 0	2212	3648	5078	6501	7917	09327	10731	12128	13519	14904	16283	17654	16
15	2236	3672	5102	6524	7941	09351	10754	12152	13543	14927	16306	17677	17
30	2260	3696	5125	6548	7964	09374	10778	12175	13566	14950	16329	17700	18
45	2284	3720	5149	6572	7988	09398	10801	12198	13589	14973	16352	17722	19
5 0	2308	3744	5173	6595	8012	09421	10824	12221	13612	14996	16375	17745	20
15	2332	3768	5197	6619	8035	09445	10848	12245	13635	15019	16398	17768	21
30	2356	3792	5220	6643	8059	09468	10871	12268	13658	15042	16420	17791	22
45	2380	3815	5244	6666	8082	09492	10894	12291	13681	15065	16443	17814	23
6 0	2404	3839	5268	6690	8106	09515	10918	12314	13704	15088	16466	17837	24
15	2428	3863	5292	6714	8129	09538	10941	12337	13727	15111	16489	17859	25
30	2452	3887	5315	6737	8153	09562	10964	12361	13751	15134	16512	17882	26
45	2476	3911	5339	6761	8176	09585	10988	12384	13774	15157	16534	17905	27
7 0	2500	3935	5363	6785	8200	09609	11011	12407	13797	15180	16557	17928	28
15	2524	3959	5387	6808	8223	09632	11034	12430	13820	15203	16580	17951	29
30	2548	3982	5410	6832	8247	09656	11058	12453	13843	15226	16603	17973	30
45	2572	4006	5434	6856	8270	09679	11081	12477	13866	15249	16626	17996	31
8 0	2596	4030	5458	6879	8294	09702	11104	12500	13889	15272	16649	18019	32
15	2620	4054	5482	6903	8318	09726	11127	12523	13912	15295	16671	18042	33
30	2644	4078	5505	6926	8341	09749	11151	12546	13935	15318	16694	18064	34
45	2668	4102	5529	6950	8365	09773	11174	12570	13958	15341	16717	18087	35
9 0	2692	4125	5553	6974	8388	09796	11198	12593	13982	15364	16740	18110	36
15	2716	4149	5577	6997	8412	09819	11221	12616	14005	15387	16763	18133	37
30	2740	4173	5600	7021	8435	09843	11244	12639	14028	15410	16786	18156	38
45	2764	4197	5624	7045	8459	09866	11267	12662	14051	15433	16809	18178	39
10 0	2787	4221	5648	7068	8482	09890	11291	12686	14074	15456	16832	18201	40
15	2811	4245	5672	7092	8506	09913	11314	12709	14097	15479	16854	18224	41
30	2835	4269	5695	7115	8529	09936	11337	12732	14120	15502	16877	18247	42
45	2859	4292	5719	7139	8553	09960	11361	12755	14143	15525	16900	18269	43
11 0	2883	4316	5743	7163	8576	09983	11384	12778	14166	15548	16923	18292	44
15	2907	4340	5766	7186	8600	10007	11407	12801	14189	15571	16946	18315	45
30	2931	4364	5790	7210	8623	10030	11431	12825	14212	15594	16969	18338	46
45	2955	4388	5814	7233	8647	10053	11454	12848	14235	15617	16992	18360	47
12 0	2979	4411	5837	7257	8670	10077	11477	12871	14259	15640	17015	18383	48
15	3003	4435	5861	7281	8694	10100	11500	12894	14282	15663	17037	18406	49
30	3027	4459	5885	7304	8717	10124	11524	12917	14305	15686	17060	18429	50
45	3051	4483	5909	7328	8741	10147	11547	12941	14328	15709	17083	18452	51
13 0	3075	4507	5932	7351	8764	10170	11570	12964	14351	15732	17106	18474	52
15	3099	4531	5956	7375	8788	10194	11594	12987	14374	15755	17129	18497	53
30	3123	4554	5980	7399	8811	10217	11617	13010	14397	15778	17152	18520	54
45	3146	4578	6003	7422	8835	10241	11640	13033	14420	15801	17175	18543	55
14 0	3170	4602	6027	7446	8858	10264	11663	13056	14443	15823	17198	18565	56
15	3194	4626	6051	7469	8882	10287	11687	13080	14466	15846	17220	18588	57
30	3218	4650	6075	7493	8905	10311	11710	13103	14489	15869	17243	18611	58
45	3242	4673	6098	7517	8929	10334	11733	13126	14512	15892	17266	18632	59

D. 24. Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
Parts	2	3	5	6	8	10	11	13	14	16	18	19	21	22	24

LOG. SINE SQUARE

	108° 30′	108° 45′	109° 0′	109° 15′	109° 30′	109° 45′	110° 0′	110° 15′	110° 30′	110° 45′	111° 0′	
	7h 14m	7h 15m	7h 16m	7h 17m	7h 18m	7h 19m	7h 20m	7h 21m	7h 22m	7h 23m	7h 24m	s.
′ ″	9·8	9·8	9·8	9·8	9·8	9·8	9·8	9·8	9·8	9·8	9·8	
0 0	18656	20017	21372	22721	24063	25399	26729	28053	29370	30682	31987	0
15	18679	20040	21395	22743	24085	25421	26751	28075	29392	30704	32009	1
30	18702	20063	21417	22765	24108	25444	26773	28097	29414	30726	32031	2
45	18724	20085	21440	22788	24130	25466	26795	28119	29436	30747	32052	3
1 0	18747	20108	21462	22810	24152	25488	26817	28141	29458	30769	32074	4
15	18770	20130	21485	22833	24174	25510	26840	28163	29480	30791	32096	5
30	18793	20153	21507	22855	24197	25532	26862	28185	29502	30813	32118	6
45	18815	20176	21530	22878	24219	25555	26884	28207	29524	30835	32139	7
2 0	18838	20198	21552	22900	24241	25577	26906	28229	29546	30856	32161	8
15	18861	20221	21575	22922	24264	25599	26928	28251	29568	30878	32183	9
30	18883	20244	21597	22945	24286	25621	26950	28273	29589	30900	32204	10
45	18906	20266	21620	22967	24308	25643	26972	28295	29611	30922	32226	11
3 0	18929	20289	21642	22990	24331	25666	26994	28317	29633	30944	32248	12
15	18952	20311	21665	23012	24353	25688	27016	28339	29655	30965	32269	13
30	18974	20334	21687	23034	24375	25710	27038	28361	29677	30987	32291	14
45	18997	20357	21710	23057	24398	25732	27061	28383	29699	31009	32313	15
4 0	19020	20379	21732	23079	24420	25754	27083	28405	29721	31031	32335	16
15	19042	20402	21755	23102	24442	25776	27105	28427	29743	31052	32356	17
30	19065	20424	21777	23124	24464	25799	27127	28449	29765	31074	32378	18
45	19088	20447	21800	23146	24487	25821	27149	28471	29786	31096	32400	19
5 0	19111	20470	21822	23169	24509	25843	27171	28493	29808	31118	32421	20
15	19133	20492	21845	23191	24531	25865	27193	28515	29830	31140	32443	21
30	19156	20515	21867	23214	24554	25887	27215	28537	29852	31161	32465	22
45	19179	20537	21890	23236	24576	25910	27237	28559	29874	31183	32486	23
6 0	19201	20560	21912	23258	24598	25932	27259	28581	29896	31205	32508	24
15	19224	20582	21935	23281	24620	25954	27281	28603	29918	31227	32530	25
30	19247	20605	21957	23303	24643	25976	27303	28625	29940	31248	32551	26
45	19269	20628	21980	23325	24665	25998	27325	28646	29961	31270	32573	27
7 0	19292	20650	22002	23348	24687	26020	27348	28668	29983	31292	32595	28
15	19315	20673	22025	23370	24710	26043	27370	28690	30005	31314	32616	29
30	19338	20695	22047	23392	24732	26065	27392	28712	30027	31335	32638	30
45	19360	20718	22070	23415	24754	26087	27414	28734	30049	31357	32660	31
8 0	19383	20741	22092	23437	24776	26109	27436	28756	30071	31379	32681	32
15	19406	20763	22115	23460	24799	26131	27458	28778	30093	31401	32703	33
30	19428	20786	22137	23482	24821	26153	27480	28800	30114	31422	32724	34
45	19451	20808	22159	23504	24843	26176	27502	28822	30136	31444	32746	35
9 0	19474	20831	22182	23527	24865	26198	27524	28844	30158	31466	32768	36
15	19496	20853	22204	23549	24888	26220	27546	28866	30180	31488	32789	37
30	19519	20876	22227	23571	24910	26242	27568	28888	30202	31509	32811	38
45	19542	20899	22249	23594	24932	26264	27590	28910	30224	31531	32833	39
10 0	19564	20921	22272	23616	24954	26286	27612	28932	30245	31553	32854	40
15	19587	20944	22294	23639	24977	26309	27634	28954	30267	31575	32876	41
30	19610	20966	22317	23661	24999	26331	27656	28976	30289	31596	32898	42
45	19632	20989	22339	23683	25021	26353	27678	28998	30311	31618	32919	43
11 0	19655	21011	22362	23706	25043	26375	27700	29020	30333	31640	32941	44
15	19678	21034	22384	23728	25066	26397	27722	29042	30355	31662	32963	45
30	19700	21056	22406	23750	25088	26419	27744	29064	30377	31683	32984	46
45	19723	21079	22429	23773	25110	26441	27767	29086	30398	31705	33006	47
12 0	19746	21102	22451	23795	25132	26463	27789	29107	30420	31727	33027	48
15	19768	21124	22474	23817	25155	26486	27811	29129	30442	31749	33049	49
30	19791	21147	22496	23840	25177	26508	27833	29151	30464	31770	33071	50
45	19814	21169	22519	23862	25199	26530	27855	29173	30486	31792	33092	51
13 0	19836	21192	22541	23884	25221	26552	27877	29195	30507	31814	33114	52
15	19859	21214	22564	23907	25243	26574	27899	29217	30529	31835	33135	53
30	19881	21237	22586	23929	25266	26596	27921	29239	30551	31857	33157	54
45	19904	21259	22609	23951	25288	26618	27943	29261	30573	31880	33179	55
14 0	19927	21282	22631	23974	25310	26641	27965	29283	30595	31901	33200	56
15	19949	21304	22653	23996	25332	26663	27987	29305	30617	31922	33222	57
30	19972	21327	22676	24018	25355	26685	28009	29327	30638	31944	33244	58
45	19995	21350	22698	24041	25377	26707	28031	29349	30660	31966	33265	59

Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D 23. Parts	2	3	5	6	8	9	11	12	14	15	17	18	20	22	23

LOG. SINE SQUARE

	111°			112°				113°				
	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	
	7h 25m	7h 26m	7h 27m	7h 28m	7h 29m	7h 30m	7h 31m	7h 32m	7h 33m	7h 34m	7h 35m	e
′ ″	9·8	9·8	9·8	9·8	9·8	9·8	9·8	9·8	9·8	9·8	9·8	
0 0	33287	34580	35867	37148	38424	39693	40956	42213	43464	44710	45949	0
15	33308	34601	35889	37170	38445	39714	40977	42234	43485	44730	45970	1
30	33330	34623	35910	37191	38466	39735	40998	42255	43506	44751	45990	2
45	33352	34644	35931	37212	38487	39756	41019	42276	43527	44772	46011	3
1 0	33373	34666	35953	37234	38508	39777	41040	42297	43548	44793	46032	4
15	33395	34687	35974	37255	38530	39798	41061	42318	43568	44813	46052	5
30	33416	34709	35996	37276	38551	39819	41082	42339	43589	44834	46073	6
45	33438	34730	36017	37297	38572	39840	41103	42359	43610	44855	46093	7
2 0	33460	34752	36038	37319	38593	39861	41124	42380	43631	44875	46114	8
15	33481	34773	36060	37340	38614	39883	41145	42401	43652	44896	46135	9
30	33503	34795	36081	37361	38636	39904	41166	42422	43672	44917	46155	10
45	33524	34816	36103	37383	38657	39925	41187	42443	43693	44937	46176	11
3 0	33546	34838	36124	37404	38678	39946	41208	42464	43714	44958	46196	12
15	33568	34859	36145	37425	38699	39967	41229	42485	43735	44979	46217	13
30	33589	34881	36167	37446	38720	39988	41250	42506	43756	45000	46238	14
45	33611	34902	36188	37468	38741	40005	41271	42526	43776	45020	46258	15
4 0	33632	34924	36209	37489	38763	40030	41292	42547	43797	45041	46279	16
15	33654	34945	36231	37510	38784	40051	41313	42568	43818	45062	46299	17
30	33675	34967	36252	37532	38805	40072	41334	42589	43839	45082	46320	18
45	33697	34988	36274	37553	38826	40093	41355	42610	43859	45103	46341	19
5 0	33718	35010	36295	37574	38847	40114	41376	42631	43880	45124	46361	20
15	33740	35031	36316	37595	38868	40136	41397	42652	43901	45144	46382	21
30	33762	35053	36338	37617	38890	40157	41418	42673	43922	45165	46402	22
45	33783	35074	36359	37638	38911	40178	41439	42693	43942	45186	46423	23
6 0	33805	35096	36380	37659	38932	40199	41460	42714	43963	45206	46443	24
15	33826	35117	36402	37680	38953	40220	41481	42735	43984	45227	46464	25
30	33848	35138	36423	37702	38974	40241	41502	42756	44005	45248	46484	26
45	33869	35160	36444	37723	38995	40262	41522	42777	44026	45268	46505	27
7 0	33891	35181	36466	37744	39017	40283	41543	42798	44046	45289	46526	28
15	33913	35203	36487	37766	39038	40304	41564	42819	44067	45310	46546	29
30	33934	35224	36509	37787	39059	40325	41585	42839	44088	45330	46567	30
45	33956	35246	36530	37808	39080	40346	41606	42860	44109	45351	46587	31
8 0	33977	35267	36551	37829	39101	40367	41627	42881	44129	45372	46608	32
15	33999	35289	36573	37851	39122	40388	41648	42902	44150	45392	46628	33
30	34020	35310	36594	37872	39143	40409	41669	42923	44171	45413	46649	34
45	34042	35332	36615	37893	39165	40430	41690	42944	44192	45434	46670	35
9 0	34063	35353	36637	37914	39186	40451	41711	42965	44212	45454	46690	36
15	34085	35375	36658	37935	39207	40472	41732	42986	44233	45475	46711	37
30	34107	35396	36679	37957	39228	40493	41753	43006	44254	45495	46731	38
45	34128	35417	36701	37978	39249	40515	41774	43027	44275	45516	46752	39
10 0	34150	35439	36722	37999	39270	40536	41795	43048	44295	45537	46772	40
15	34171	35460	36743	38020	39292	40557	41816	43069	44316	45557	46793	41
30	34193	35482	36765	38042	39313	40578	41837	43090	44337	45578	46814	42
45	34214	35503	36786	38063	39334	40599	41858	43111	44358	45599	46834	43
11 0	34236	35525	36807	38084	39355	40620	41878	43131	44378	45619	46854	44
15	34257	35546	36829	38105	39376	40641	41900	43152	44399	45640	46875	45
30	34279	35567	36850	38127	39397	40662	41920	43173	44420	45661	46895	46
45	34300	35589	36871	38148	39418	40683	41941	43194	44441	45681	46916	47
12 0	34322	35610	36893	38169	39439	40704	41962	43215	44461	45702	46937	48
15	34343	35632	36914	38190	39460	40725	41983	43235	44482	45722	46957	49
30	34365	35653	36935	38211	39482	40746	42004	43256	44503	45743	46978	50
45	34386	35675	36957	38233	39513	40767	42025	43277	44523	45764	46998	51
13 0	34408	35696	36978	38254	39524	40788	42046	43298	44544	45784	47019	52
15	34429	35717	36999	38275	39545	40809	42067	43319	44565	45805	47039	53
30	34451	35739	37021	38296	39566	40830	42088	43340	44586	45826	47060	54
45	34472	35760	37042	38318	39587	40851	42109	43360	44606	45846	47080	55
14 0	34494	35782	37063	38339	39608	40872	42130	43381	44627	45867	47101	56
15	34515	35803	37084	38360	39629	40893	42150	43402	44648	45887	47121	57
30	34537	35824	37106	38381	39651	40914	42171	43423	44668	45908	47142	58
45	34558	35846	37127	38402	39672	40933	42192	43444	44689	45929	47162	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 21.	Parts	1	3	4	6	7	8	10	11	13	14	15	17	18	20	21

LOG. SINE SQUARE

	114°				115°				116°			
	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	
	$7^h 36^m$	$7^h 37^m$	$7^h 38^m$	$7^h 39^m$	$7^h 40^m$	$7^h 41^m$	$7^h 42^m$	$7^h 43^m$	$7^h 44^m$	$7^h 45^m$	$7^h 46^m$	s.
′ ″	9·8	9·8	9·8	9·8	9·8	9·8	9·8	9·8	9·8	9·8	9·8	
0 0	47183	48410	49632	50848	52058	53263	54461	55654	56841	58022	59198	0
15	47203	48431	49653	50868	52078	53283	54481	55674	56861	58042	59217	1
30	47224	48451	49673	50889	52099	53303	54501	55694	56880	58061	59237	2
45	47244	48472	49693	50909	52119	53323	54521	55713	56900	58081	59257	3
1 0	47265	48492	49713	50929	52139	53343	54541	55733	56920	58101	59276	4
15	47285	48512	49734	50949	52159	53363	54561	55753	56940	58120	59295	5
30	47306	48533	49754	50969	52179	53383	54581	55773	56959	58140	59315	6
45	47326	48553	49774	50990	52199	53403	54601	55793	56979	58160	59334	7
2 0	47347	48574	49795	51010	52219	53423	54621	55813	56999	58179	59354	8
15	47367	48594	49815	51030	52239	53443	54640	55832	57019	58199	59373	9
30	47388	48615	49835	51050	52260	53463	54660	55852	57038	58219	59393	10
45	47408	48635	49856	51071	52280	53483	54680	55872	57058	58238	59413	11
3 0	47429	48655	49876	51091	52300	53503	54700	55892	57078	58258	59432	12
15	47449	48676	49896	51111	52320	53523	54720	55912	57097	58277	59452	13
30	47470	48696	49917	51131	52340	53543	54740	55931	57117	58297	59471	14
45	47490	48716	49937	51151	52360	53563	54760	55951	57137	58317	59491	15
4 0	47511	48737	49957	51172	52380	53583	54780	55971	57157	58336	59510	16
15	47531	48757	49977	51192	52400	53603	54800	55991	57176	58356	59530	17
30	47552	48778	49998	51212	52420	53623	54820	56011	57196	58375	59549	18
45	47572	48798	50018	51232	52440	53643	54840	56030	57216	58395	59569	19
5 0	47593	48818	50038	51252	52460	53663	54860	56050	57235	58415	59588	20
15	47613	48839	50059	51272	52481	53683	54879	56070	57255	58434	59608	21
30	47634	48859	50079	51293	52501	53703	54899	56090	57275	58454	59627	22
45	47654	48879	50099	51313	52521	53723	54919	56110	57294	58473	59647	23
6 0	47675	48900	50119	51333	52541	53743	54939	56129	57314	58493	59666	24
15	47695	48920	50140	51353	52561	53763	54959	56149	57334	58513	59686	25
30	47715	48941	50160	51373	52581	53783	54979	56169	57354	58532	59705	26
45	47736	48961	50180	51393	52601	53803	54999	56189	57373	58552	59725	27
7 0	47756	48981	50200	51414	52621	53823	55019	56209	57393	58571	59744	28
15	47777	49002	50221	51434	52641	53843	55039	56228	57413	58591	59764	29
30	47797	49022	50241	51454	52661	53863	55058	56248	57432	58611	59783	30
45	47818	49042	50261	51474	52681	53883	55078	56268	57452	58630	59803	31
8 0	47838	49063	50282	51494	52701	53903	55098	56288	57472	58650	59822	32
15	47859	49083	50302	51515	52721	53923	55118	56308	57491	58669	59842	33
30	47879	49103	50322	51535	52742	53943	55138	56327	57511	58689	59861	34
45	47900	49124	50342	51555	52762	53963	55158	56347	57531	58709	59881	35
9 0	47920	49144	50363	51575	52782	53982	55178	56367	57550	58728	59900	36
15	47941	49165	50383	51595	52802	54002	55197	56387	57570	58748	59920	37
30	47961	49185	50403	51615	52822	54022	55217	56406	57590	58767	59939	38
45	47981	49205	50423	51635	52842	54042	55237	56426	57609	58787	59959	39
10 0	48002	49226	50444	51656	52862	54062	55257	56446	57629	58806	59978	40
15	48022	49246	50464	51676	52882	54082	55277	56466	57649	58826	59998	41
30	48043	49266	50484	51696	52902	54102	55297	56485	57668	58846	60017	42
45	48063	49287	50504	51716	52922	54122	55317	56505	57688	58865	60037	43
11 0	48084	49307	50525	51736	52942	54142	55336	56525	57708	58885	60056	44
15	48104	49327	50545	51756	52962	54162	55356	56545	57727	58904	60075	45
30	48125	49348	50565	51777	52982	54182	55376	56564	57747	58924	60095	46
45	48145	49368	50585	51797	53002	54202	55396	56584	57767	58944	60114	47
12 0	48166	49388	50605	51817	53022	54222	55416	56604	57786	58963	60134	48
15	48186	49409	50626	51837	53042	54242	55436	56624	57806	58983	60153	49
30	48207	49429	50646	51857	53062	54262	55455	56643	57826	59002	60173	50
45	48227	49449	50666	51877	53082	54282	55475	56663	57845	59022	60192	51
13 0	48247	49470	50686	51897	53102	54302	55495	56683	57865	59041	60212	52
15	48267	49490	50707	51918	53123	54322	55515	56703	57885	59061	60231	53
30	48288	49510	50727	51938	53143	54342	55535	56722	57904	59080	60251	54
45	48308	49531	50747	51958	53163	54362	55555	56742	57924	59100	60270	55
14 0	48329	49551	50767	51978	53183	54381	55575	56762	57944	59120	60290	56
15	48349	49571	50788	51998	53203	54401	55594	56782	57963	59139	60309	57
30	48370	49592	50808	52018	53223	54421	55614	56801	57983	59159	60328	58
45	48390	49612	50828	52038	53243	54441	55634	56821	58003	59178	60348	59

	Sec.	1″	2	3	4″	5″	6	7	8″	9″	10″	11	12	13″	14″	15″
D. 20	Parts	1	3	4	5	7	8	9	11	12	13	15	16	17	19	20

LOG. SINE SQUARE

	116°	117°				118°				119°		
	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	
	7h 47m	7h 48m	7h 49m	7h 50m	7h 51m	7h 52m	7h 53m	7h 54m	7h 55m	7h 56m	7h 57m	s.
′ ″	9·8	9·8	9·8	9·8	9·8	9·8	9·8	9·8	9·8	9·8	9·8	
0 0	60367	61532	62690	63843	64990	66131	67267	68397	69522	70641	71754	0
15	60387	61551	62709	63862	65009	66150	67286	68416	69540	70659	71773	1
30	60406	61570	62728	63881	65028	66169	67305	68435	69559	70678	71791	2
45	60426	61590	62748	63900	65047	66188	67324	68454	69578	70697	71810	3
1 0	60445	61609	62767	63919	65066	66207	67342	68472	69597	70715	71828	4
15	60465	61628	62786	63938	65085	66226	67361	68491	69615	70734	71847	5
30	60484	61648	62805	63958	65104	66245	67380	68510	69634	70752	71865	6
45	60504	61667	62825	63977	65123	66264	67399	68529	69653	70771	71884	7
2 0	60523	61686	62844	63996	65142	66283	67418	68547	69671	70790	71902	8
15	60542	61706	62863	64015	65161	66302	67437	68566	69690	70808	71921	9
30	60562	61725	62882	64034	65180	66321	67456	68585	69709	70827	71939	10
45	60581	61744	62902	64053	65199	66340	67475	68604	69727	70845	71958	11
3 0	60601	61764	62921	64073	65218	66359	67493	68622	69746	70864	71976	12
15	60620	61783	62940	64092	65238	66378	67512	68641	69765	70882	71995	13
30	60640	61802	62959	64111	65257	66397	67531	68660	69783	70901	72013	14
45	60659	61822	62979	64130	65276	66416	67550	68679	69802	70920	72032	15
4 0	60678	61841	62998	64149	65295	66435	67569	68698	69821	70938	72050	16
15	60698	61860	63017	64168	65314	66454	67588	68716	69839	70957	72069	17
30	60717	61880	63036	64187	65333	66472	67607	68735	69858	70975	72087	18
45	60737	61899	63056	64207	65352	66491	67625	68754	69877	70994	72106	19
5 0	60756	61918	63075	64226	65371	66510	67644	68773	69895	71012	72124	20
15	60776	61938	63094	64245	65390	66529	67663	68791	69914	71031	72143	21
30	60795	61957	63113	64264	65409	66548	67682	68810	69933	71050	72161	22
45	60814	61976	63132	64283	65428	66567	67701	68829	69951	71068	72179	23
6 0	60834	61995	63152	64302	65447	66586	67720	68848	69970	71087	72198	24
15	60853	62015	63171	64321	65466	66605	67739	68866	69989	71105	72216	25
30	60873	62034	63190	64340	65485	66624	67757	68885	70007	71124	72235	26
45	60892	62053	63209	64360	65504	66643	67776	68904	70026	71143	72253	27
7 0	60911	62073	63228	64379	65523	66662	67795	68923	70045	71161	72272	28
15	60931	62092	63248	64398	65542	66681	67814	68941	70063	71180	72290	29
30	60950	62111	63267	64417	65561	66700	67833	68960	70082	71198	72309	30
45	60970	62131	63286	64436	65580	66719	67852	68979	70101	71217	72327	31
8 0	60989	62150	63305	64455	65599	66738	67870	68998	70119	71235	72346	32
15	61008	62169	63325	64474	65618	66757	67889	69016	70138	71254	72364	33
30	61028	62189	63344	64493	65637	66775	67908	69035	70157	71272	72383	34
45	61047	62208	63363	64512	65656	66794	67927	69054	70175	71291	72401	35
9 0	61067	62227	63382	64532	65675	66813	67946	69073	70194	71310	72420	36
15	61086	62246	63401	64551	65694	66832	67965	69091	70212	71328	72438	37
30	61105	62266	63421	64570	65713	66851	67984	69110	70231	71347	72456	38
45	61125	62285	63440	64589	65732	66870	68002	69129	70250	71365	72475	39
10 0	61144	62304	63459	64608	65751	66889	68021	69147	70268	71384	72493	40
15	61164	62324	63478	64627	65770	66908	68040	69166	70287	71402	72512	41
30	61183	62343	63497	64646	65789	66927	68059	69185	70306	71421	72530	42
45	61202	62362	63517	64665	65808	66946	68077	69204	70324	71439	72549	43
11 0	61222	62381	63536	64684	65827	66965	68096	69222	70343	71458	72567	44
15	61241	62401	63555	64703	65846	66984	68115	69241	70362	71476	72586	45
30	61261	62420	63574	64723	65865	67002	68134	69260	70380	71495	72604	46
45	61280	62439	63593	64742	65884	67021	68153	69279	70399	71513	72623	47
12 0	61299	62459	63613	64761	65903	67040	68172	69297	70417	71532	72641	48
15	61319	62478	63632	64780	65922	67059	68190	69316	70436	71551	72659	49
30	61338	62497	63651	64799	65941	67078	68209	69335	70455	71569	72678	50
45	61357	62517	63670	64818	65960	67097	68228	69353	70473	71588	72696	51
13 0	61377	62536	63689	64837	65979	67116	68247	69372	70492	71606	72715	52
15	61396	62555	63709	64856	65998	67135	68266	69391	70511	71625	72733	53
30	61415	62574	63728	64875	66017	67154	68284	69410	70529	71643	72752	54
45	61435	62594	63747	64894	66036	67173	68303	69428	70548	71662	72770	55
14 0	61454	62613	63766	64913	66055	67191	68322	69447	70566	71680	72788	56
15	61474	62632	63785	64933	66074	67210	68341	69466	70585	71699	72807	57
30	61493	62651	63804	64952	66093	67229	68360	69484	70604	71717	72825	58
45	61512	62671	63823	64971	66112	67248	68378	69503	70622	71736	72844	59

D. 19. Sec. 1″ 2 3 4″ 5″ 6″ 7″ 8″ 9″ 10″ 11″ 12″ 13″ 14″ 15″
Parts 1 3 4 5 6 8 9 10 11 13 14 15 17 18 19

LOG. SINE SQUARE

	119°		120°				121°				122°		
	30′	45′	0′	15′	30	45′	0′	15′	30′	45′	0′	15′	
	7h 58m	7h 59m	8h 0m	8h 1m	8h 2m	8h 3m	8h 4m	8h 5m	8h 6m	8h 7m	8h 8m	8h 9m	s.
′ ″	9·8	9·8	9·8	9·8	9·8	9·87	9·8	9·88	9·88	9·88	9·88	9·88	
0 0	72862	73964	75061	76153	77238	8319	79394	0463	1527	2585	3639	4686	0
15	72881	73983	75080	76171	77256	8337	79411	0481	1545	2603	3656	4704	1
30	72899	74001	75098	76189	77274	8355	79429	0499	1562	2621	3674	4721	2
45	72917	74019	75116	76207	77293	8373	79447	0516	1580	2638	3691	4738	3
1 0	72936	74038	75134	76225	77311	8391	79465	0534	1598	2656	3709	4756	4
15	72954	74056	75152	76243	77329	8408	79483	0552	1615	2673	3726	4773	5
30	72973	74074	75171	76261	77347	8426	79501	0570	1633	2691	3744	4791	6
45	72991	74093	75189	76280	77365	8444	79519	0587	1651	2709	3761	4808	7
2 0	73009	74111	75207	76298	77383	8462	79536	0605	1668	2726	3778	4826	8
15	73028	74129	75225	76316	77401	8480	79554	0623	1686	2744	3796	4843	9
30	73046	74148	75244	76334	77419	8498	79572	0641	1704	2761	3813	4860	10
45	73065	74166	75262	76352	77437	8516	79590	0658	1721	2779	3831	4878	11
3 0	73083	74184	75280	76370	77455	8534	79608	0676	1739	2796	3848	4895	12
15	73101	74202	75298	76389	77473	8552	79626	0694	1757	2814	3866	4913	13
30	73120	74221	75316	76406	77491	8570	79644	0712	1774	2832	3883	4930	14
45	73138	74239	75335	76425	77509	8588	79661	0729	1792	2849	3901	4947	15
4 0	73157	74257	75353	76443	77527	8606	79679	0747	1810	2867	3918	4965	16
15	73175	74276	75371	76461	77545	8624	79697	0765	1827	2884	3936	4982	17
30	73193	74294	75389	76479	77563	8642	79715	0783	1845	2902	3953	4999	18
45	73212	74312	75407	76497	77581	8660	79733	0800	1863	2920	3971	5017	19
5 0	73230	74331	75426	76515	77599	8678	79751	0818	1880	2937	3988	5034	20
15	73249	74349	75444	76533	77617	8696	79768	0836	1898	2955	4006	5052	21
30	73267	74367	75462	76551	77635	8713	79786	0854	1916	2972	4023	5069	22
45	73285	74386	75480	76569	77653	8731	79804	0871	1933	2990	4041	5086	23
6 0	73304	74404	75498	76588	77671	8749	79822	0889	1951	3007	4058	5104	24
15	73322	74422	75517	76606	77689	8767	79840	0907	1969	3025	4076	5121	25
30	73340	74440	75534	76624	77707	8785	79858	0925	1986	3042	4093	5138	26
45	73359	74459	75553	76642	77725	8803	79875	0942	2004	3060	4111	5156	27
7 0	73377	74477	75571	76660	77743	8821	79893	0960	2022	3078	4128	5173	28
15	73396	74495	75589	76678	77761	8839	79911	0978	2039	3095	4146	5191	29
30	73414	74514	75608	76696	77779	8857	79929	0996	2057	3113	4163	5208	30
45	73432	74532	75626	76714	77797	8875	79947	1013	2074	3130	4181	5225	31
8 0	73451	74550	75644	76732	77815	8893	79965	1031	2092	3148	4198	5243	32
15	73469	74568	75662	76750	77833	8911	79982	1049	2110	3165	4215	5260	33
30	73487	74587	75680	76769	77851	8928	80000	1067	2127	3183	4233	5277	34
45	73506	74605	75699	76787	77869	8946	80018	1084	2145	3200	4250	5295	35
9 0	73524	74623	75717	76805	77887	8964	80036	1102	2163	3218	4268	5312	36
15	73543	74641	75735	76823	77905	8982	80054	1120	2180	3235	4285	5330	37
30	73561	74660	75753	76841	77922	9000	80071	1137	2198	3253	4303	5347	38
45	73579	74678	75771	76859	77941	9018	80089	1155	2216	3271	4320	5364	39
10 0	73598	74696	75789	76877	77959	9036	80107	1173	2233	3288	4338	5382	40
15	73616	74715	75808	76895	77977	9054	80125	1191	2251	3306	4355	5399	41
30	73634	74733	75826	76913	77995	9072	80143	1208	2268	3323	4372	5416	42
45	73653	74751	75844	76931	78013	9089	80160	1226	2286	3341	4390	5434	43
11 0	73671	74769	75862	76949	78031	9107	80178	1244	2304	3358	4407	5451	44
15	73689	74788	75880	76967	78049	9125	80196	1261	2321	3376	4425	5468	45
30	73708	74806	75898	76986	78067	9143	80214	1279	2339	3393	4442	5486	46
45	73726	74824	75917	77004	78085	9161	80232	1297	2357	3411	4460	5503	47
12 0	73744	74842	75935	77022	78103	9179	80249	1315	2374	3428	4477	5520	48
15	73763	74861	75953	77040	78121	9197	80267	1332	2392	3446	4495	5538	49
30	73781	74879	75971	77058	78139	9215	80285	1350	2409	3463	4512	5555	50
45	73799	74897	75989	77076	78157	9233	80303	1368	2427	3481	4529	5572	51
13 0	73818	74915	76007	77094	78175	9251	80321	1385	2445	3498	4547	5590	52
15	73836	74934	76026	77112	78193	9268	80338	1403	2462	3516	4564	5607	53
30	73854	74952	76044	77130	78211	9286	80356	1421	2480	3533	4582	5624	54
45	73873	74970	76062	77148	78229	9304	80374	1438	2497	3551	4599	5642	55
14 0	73891	74988	76080	77166	78247	9322	80392	1456	2515	3568	4617	5659	56
15	73909	75007	76098	77184	78265	9340	80410	1474	2533	3586	4634	5677	57
30	73928	75025	76116	77202	78283	9358	80427	1491	2550	3604	4651	5694	58
45	73946	75043	76134	77220	78301	9376	80445	1509	2568	3621	4669	5711	59

	Sec.	1″	2″	3″	4″	5″	6″	7	8	9″	10	11″	12″	13	14″	15
D 18.	Parts	1	2	4	5	6	7	8	10	11	12	13	14	16	17	18

LOG. SINE SQUARE

	122°		123°				124°				125	
	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	
	8h 10m	8h 11m	8h 12m	8h 13m	8h 14m	8h 15m	8h 16m	8h 17m	8h 18m	8h 19m	8h 20m	s
′ ″	9·8	9·8	9·8	9·8	9·8	9·8	9·8	9·8	9·8	9·8	9·8	
0 0	85729	86765	87797	88823	89844	90860	91870	92875	93874	94869	95858	0
15	85746	86783	87814	88840	89861	90876	91887	92891	93891	94885	95874	1
30	85763	86800	87831	88857	89878	90893	91903	92908	93908	94902	95891	2
45	85781	86817	87848	88874	89895	90910	91920	92925	93924	94918	95907	3
1 0	85798	86834	87866	88891	89912	90927	91937	92942	93941	94935	95924	4
15	85815	86852	87883	88908	89929	90944	91954	92958	93957	94951	95940	5
30	85832	86869	87900	88925	89946	90961	919 1	92975	93974	94968	95956	6
45	85850	86886	87917	88943	89963	90978	91987	92992	93991	94984	95973	7
2 0	85867	86903	87934	88960	89980	90995	92004	93008	94007	95001	95989	8
15	85884	86920	87951	88977	89997	91011	92021	93025	94024	95017	96006	9
30	85902	86938	87968	88994	90014	91028	92038	93042	94040	95034	96022	10
45	85919	86955	87986	89011	90031	91045	92054	93058	94057	95050	96039	11
3 0	85936	86972	88003	89028	90048	91062	92071	93075	94074	95067	96055	12
15	85954	86989	88020	89045	90065	91079	92088	93092	94090	95083	96071	13
30	85971	87007	88037	89062	90081	91096	92105	93108	94107	95100	96088	14
45	85988	87024	88054	89079	90098	91113	92122	93125	94123	95116	96104	15
4 9	86006	87041	88071	89096	90115	91129	92138	93142	94140	95133	96121	16
15	86023	87058	88088	89113	90132	91146	92155	93159	94157	95149	96137	17
30	86040	87075	88105	89130	90149	91163	92172	93175	94173	95166	96154	18
45	86057	87093	88123	89147	90166	91180	92189	93192	94190	95182	96170	19
5 0	86075	87110	88140	89164	90183	91197	92205	93209	94206	95199	96186	20
15	86092	87127	88157	89181	90200	91214	92222	93225	94223	95215	96203	21
30	86109	87144	88174	89198	90217	91231	92239	93242	94240	95232	96219	22
45	86127	87162	88191	89215	90234	91247	92256	93259	94256	95248	96236	23
6 0	86144	87179	88208	89232	90251	91264	92272	93275	94273	95265	96252	24
15	86161	87196	88225	89249	90268	91281	92289	93292	94289	95281	96268	25
30	86178	87213	88242	89266	90285	91298	92306	93309	94306	95298	96285	26
45	86196	87230	88259	89283	90302	91315	92323	93325	94322	95314	96301	27
7 0	86213	87248	88277	89300	90319	91332	92339	93342	94339	95331	96318	28
15	86230	87265	88294	89317	90336	91349	92356	93359	94356	95347	96334	29
30	86248	87282	88311	89334	90352	91365	92373	93375	94372	95364	96350	30
45	86265	87299	88328	89351	90369	91382	92390	93392	94389	95380	96367	31
8 0	86282	87316	88345	89368	90386	91399	92406	93409	94405	95397	96383	32
15	86299	87333	88362	89385	90403	91416	92423	93425	94422	95413	96400	33
30	86317	87351	88379	89402	90420	91433	92440	93442	94439	95430	96416	34
45	86334	87368	88396	89419	90437	91450	92457	93459	94455	95446	96432	35
9 0	86351	87385	88413	89436	90454	91466	92473	93475	94472	95463	96449	36
15	86369	87402	88430	89453	90471	91483	92490	93492	94488	95479	96465	37
30	86386	87419	88447	89470	90488	91500	92507	93508	94505	95496	96482	38
45	86403	87437	88465	89487	90505	91517	92524	93525	94521	95512	96498	39
10 0	86420	87454	88482	89504	90522	91534	92540	93542	94538	95529	96514	40
15	86438	87471	88499	89521	90539	91551	92557	93558	94554	95545	96531	41
30	86455	87488	88516	89538	90555	91567	92574	93575	94571	95562	96547	42
45	86472	87505	88533	89555	90572	91584	92591	93592	94587	95578	96563	43
11 0	86489	87522	88550	89572	90589	91601	92607	93608	94604	95595	96580	44
15	86507	87540	88567	89589	90606	91618	92624	93625	94621	95611	96596	45
30	86524	87557	88584	89606	90623	91635	92641	93642	94637	95628	96613	46
45	86541	87574	88601	89623	90640	91651	92657	93658	94654	95644	96629	47
12 0	86558	87591	88618	89640	90657	91668	92674	93675	94670	95660	96645	48
15	86576	87608	88635	89657	90674	91685	92691	93691	94687	95677	96662	49
30	86593	87625	88652	89674	90691	91702	92708	93708	94703	95693	96678	50
45	86610	87643	88670	89691	90708	91719	92724	93725	94720	95710	96694	51
13 0	86627	87660	88687	89708	90724	91735	92741	93741	94736	95726	96711	52
15	86645	87677	88704	89725	90741	91752	92758	93758	94753	95743	96727	53
30	86662	87694	88721	89742	90758	91769	92775	93775	94770	95759	96744	54
45	86679	87711	88738	89759	90775	91786	92791	93791	94786	95776	96760	55
14 0	86696	87728	88755	89776	90792	91803	92808	93808	94803	95792	96776	56
15	86714	87746	88772	89793	90809	91819	92825	93825	94819	95808	96793	57
30	86731	87763	88789	89810	90826	91836	92841	93841	94836	95825	96809	58
45	86748	87780	88806	89827	90843	91853	92858	93858	94852	95841	96825	59

D 17.	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
	Parts	1	2	3	5	6	7	8	9	10	11	12	14	15	16	17

LOG. SINE SQUARE

	125°			126°				127°				
	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	
	8ʰ 21ᵐ	8ʰ 22ᵐ	8ʰ 23ᵐ	8ʰ 24ᵐ	8ʰ 25ᵐ	8ʰ 26ᵐ	8ʰ 27ᵐ	8ʰ 28ᵐ	8ʰ 29ᵐ	8ʰ 30ᵐ	8ʰ 31ᵐ	s.
′ ″	9·8	9·8	9·8	9·	9·9	9·9	9·9	9·9	9·9	9·9	9·9	
0 0	96842	97820	98794	899762	00725	01682	02635	03582	04525	05462	06394	0
15	96858	97836	98810	899778	00741	01698	02651	03598	04540	05477	06409	1
30	96874	97853	98826	899794	00757	01714	02667	03614	04556	05493	06425	2
45	96891	97869	98842	899810	00773	01730	02682	03630	04572	05508	06440	3
1 0	96907	97885	98858	899826	00789	01746	02698	03645	04587	05524	06456	4
15	96923	97902	98874	899842	00805	01762	02714	03661	04603	05539	06471	5
30	96940	97918	98891	899858	00821	01778	02730	03677	04618	05555	06486	6
45	96956	97934	98907	899874	00837	01794	02746	03693	04634	05571	06502	7
2 0	96972	97950	98923	899890	00853	01810	02762	03708	04650	05586	06517	8
15	96989	97967	98939	899906	00869	01826	02777	03724	04665	05602	06533	9
30	97005	97983	98955	899923	00885	01842	02793	03740	04681	05617	06548	10
45	97021	97999	98971	899939	00901	01857	02809	03756	04697	05633	06564	11
3 0	97038	98015	98988	899955	00917	01873	02825	03771	04712	05648	06579	12
15	97054	98032	99004	899971	00933	01889	02841	03787	04728	05664	06595	13
30	97070	98048	99020	899987	00949	01905	02856	03803	04744	05679	06610	14
45	97087	98064	99036	900003	00965	01921	02872	03818	04759	05695	06626	15
4 0	97103	98080	99052	900019	00981	01937	02888	03834	04775	05711	06641	16
15	97119	98097	99068	900035	00997	01953	02904	03850	04791	05726	06657	17
30	97136	98113	99085	900051	01012	01969	02920	03866	04806	05742	06672	18
45	97152	98129	99101	900067	01028	01985	02935	03881	04822	05757	06688	19
5 0	97168	98145	99117	900083	01044	02001	02951	03897	04837	05773	06703	20
15	97185	98162	99133	900099	01060	02016	02967	03913	04853	05788	06719	21
30	97201	98178	99149	900115	01076	02032	02983	03928	04869	05804	06734	22
45	97217	98194	99165	900131	01092	02048	02999	03944	04884	05819	06749	23
6 0	97234	98210	99181	900148	01108	02064	03015	03960	04900	05835	06765	24
15	97250	98226	99198	900164	01124	02080	03030	03976	04916	05851	06780	25
30	97266	98243	99214	900180	01140	02096	03046	03991	04931	05866	06796	26
45	97283	98259	99230	900196	01156	02112	03062	04007	04947	05882	06811	27
7 0	97299	98275	99246	900212	01172	02128	03078	04023	04962	05897	06827	28
15	97315	98291	99262	900228	01188	02144	03094	04038	04978	05913	06842	29
30	97332	98307	99278	900244	01204	02159	03109	04054	04994	05928	06858	30
45	97348	98324	99294	900260	01220	02175	03125	04070	05009	05944	06873	31
8 0	97364	98340	99311	900276	01236	02191	03141	04086	05025	05959	06889	32
15	97380	98356	99327	900292	01252	02207	03157	04101	05041	05975	06904	33
30	97397	98372	99343	900308	01268	02223	03172	04117	05056	05990	06919	34
45	97413	98389	99359	900324	01284	02239	03188	04133	05072	06006	06935	35
9 0	97429	98405	99375	900340	01300	02255	03204	04148	05087	06021	06950	36
15	97446	98421	99391	900356	01316	02270	03220	04164	05103	06037	06966	37
30	97462	98437	99407	900372	01332	02286	03236	04180	05119	06052	06981	38
45	97478	98453	99424	900388	01348	02302	03251	04195	05134	06068	06997	39
10 0	97495	98470	99440	900404	01364	02318	03267	04211	05150	06083	07012	40
15	97511	98486	99456	900420	01380	02334	03283	04227	05165	06099	07027	41
30	97527	98502	99472	900436	01396	02350	03299	04242	05181	06115	07043	42
45	97543	98518	99488	900452	01412	02366	03314	04258	05197	06130	07058	43
11 0	97560	98535	99504	900468	01427	02381	03330	04274	05212	06146	07074	44
15	97576	98551	99520	900484	01443	02397	03346	04289	05228	06161	07089	45
30	97592	98567	99536	900500	01459	02413	03362	04305	05243	06177	07105	46
45	97609	98583	99552	900516	01475	02429	03377	04321	05259	06192	07120	47
12 0	97625	98599	99569	900532	01491	02445	03393	04337	05275	06208	07135	48
15	97641	98616	99585	900548	01507	02461	03409	04352	05290	06223	07151	49
30	97658	98632	99601	900565	01523	02477	03425	04368	05306	06239	07166	50
45	97674	98648	99617	900581	01539	02492	03441	04384	05321	06254	07182	51
13 0	97690	98664	99633	900597	01555	02508	03456	04399	05337	06270	07197	52
15	97706	98680	99649	900613	01571	02524	03472	04415	05353	06285	07213	53
30	97723	98697	99665	900629	01587	02540	03488	04431	05368	06301	07228	54
45	97739	98713	99681	900645	01603	02556	03504	04446	05384	06316	07243	55
14 0	97755	98729	99697	900661	01619	02572	03519	04462	05399	06332	07259	56
15	97771	98745	99713	900677	01635	02587	03535	04478	05415	06347	07274	57
30	97788	98761	99730	900693	01651	02603	03551	04493	05430	06363	07290	58
45	97804	98777	99746	900709	01666	02619	03567	04509	05446	06378	07305	59

Sec.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
D 16 Part	1	2	3	4	5	6	7	8	9	11	12	13	14	15	16

LOG. SINE SQUARE

	128°				129°				130°			
	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	
	8h 32m	8h 33m	8h 34m	8h 35m	8h 36m	8h 37m	8h 38m	8h 39m	8h 40m	8h 41m	8h 42m	s.
′ ″	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	
0 0	07320	08242	09159	10070	10976	11878	12774	13665	14551	15433	16309	0
15	07336	08257	09174	10085	10992	11893	12789	13680	14566	15447	16323	1
30	07351	08273	09189	10100	11007	11908	12804	13695	14581	15462	16338	2
45	07367	08288	09204	10116	11022	11923	12819	13710	14596	15476	16352	3
1 0	07382	08303	09220	10131	11037	11938	12834	13724	14610	15491	16367	4
15	07397	08319	09235	10146	11052	11953	12848	13739	14625	15506	16381	5
30	07413	08334	09250	10161	11067	11968	12863	13754	14640	15520	16396	6
45	07428	08349	09265	10176	11082	11983	12878	13769	14654	15535	16411	7
2 0	07444	08365	09280	10191	11097	11998	12893	13784	14669	15550	16425	8
15	07459	08380	09296	10206	11112	12012	12908	13799	14684	15564	16440	9
30	07474	08395	09311	10222	11127	12027	12923	13813	14699	15579	16454	10
45	07490	08410	09326	10237	11142	12042	12938	13828	14713	15594	16469	11
3 0	07505	08426	09341	10252	11157	12057	12953	13843	14728	15608	16483	12
15	07520	08441	09357	10267	11172	12072	12968	13858	14743	15623	16498	13
30	07536	08456	09372	10282	11187	12087	12982	13873	14757	15637	16512	14
45	07551	08472	09387	10297	11202	12102	12997	13887	14772	15652	16527	15
4 0	07567	08487	09402	10312	11217	12117	13012	13902	14787	15667	16541	16
15	07582	08502	09417	10327	11232	12132	13027	13917	14801	15681	16556	17
30	07597	08518	09433	10343	11247	12147	13042	13932	14816	15696	16570	18
45	07613	08533	09449	10358	11262	12162	13057	13946	14831	15710	16585	19
5 0	07628	08548	09463	10373	11277	12177	13072	13961	14846	15725	16600	20
15	07644	08563	09478	10388	11293	12192	13087	13976	14860	15740	16614	21
30	07659	08579	09493	10403	11308	12207	13101	13991	14875	15754	16629	22
45	07674	08594	09509	10418	11323	12222	13116	14006	14890	15769	16643	23
6 0	07690	08609	09524	10433	11338	12237	13131	14020	14904	15783	16658	24
15	07705	08625	09539	10448	11353	12252	13146	14035	14919	15798	16672	25
30	07720	08640	09554	10464	11368	12267	13161	14049	14934	15813	16687	26
45	07736	08655	09569	10479	11383	12282	13176	14065	14948	15827	16701	27
7 0	07751	08670	09585	10494	11398	12297	13191	14079	14963	15842	16716	28
15	07766	08686	09600	10509	11413	12312	13205	14094	14978	15857	16730	29
30	07782	08701	09615	10524	11428	12326	13220	14109	14993	15871	16745	30
45	07797	08716	09630	10539	11443	12341	13235	14124	15007	15886	16759	31
8 0	07813	08731	09645	10554	11458	12356	13250	14139	15022	15900	16774	32
15	07828	08747	09661	10569	11473	12371	13265	14153	15037	15915	16788	33
30	07843	08762	09676	10584	11488	12386	13280	14168	15051	15930	16803	34
45	07859	08777	09691	10599	11503	12401	13294	14183	15066	15944	16817	35
9 0	07874	08793	09706	10615	11518	12416	13309	14198	15081	15959	16832	36
15	07889	08808	09721	10630	11533	12431	13324	14212	15095	15973	16846	37
30	07906	08823	09736	10645	11548	12446	13339	14227	15110	15988	16861	38
45	07920	08838	09752	10660	11563	12461	13354	14242	15125	16003	16875	39
10 0	07935	08854	09767	10675	11578	12476	13369	14257	15139	16017	16890	40
15	07951	08869	09782	10690	11593	12491	13383	14271	15154	16032	16904	41
30	07966	08884	09797	10705	11608	12506	13398	14286	15169	16046	16919	42
45	07981	08899	09812	10720	11623	12521	13413	14301	15183	16061	16933	43
11 0	07997	08915	09828	10735	11638	12535	13428	14316	15198	16075	16948	44
15	08012	08930	09843	10750	11653	12550	13443	14330	15213	16090	16962	45
30	08027	08945	09858	10765	11668	12565	13458	14345	15227	16105	16977	46
45	08043	08960	09873	10781	11683	12580	13472	14360	15242	16119	16991	47
12 0	08058	08976	09888	10796	11698	12595	13487	14374	15257	16134	17006	48
15	08073	08991	09903	10811	11713	12610	13502	14389	15271	16148	17020	49
30	08089	09006	09919	10826	11728	12625	13517	14404	15286	16163	17035	50
45	08104	09021	09934	10841	11743	12640	13532	14419	15301	16178	17049	51
13 0	08119	09037	09949	10856	11758	12655	13547	14433	15315	16192	17064	52
15	08135	09052	09964	10871	11773	12670	13561	14448	15330	16207	17078	53
30	08150	09067	09979	10886	11788	12685	13576	14463	15345	16221	17093	54
45	08165	09082	09994	10901	11803	12700	13591	14478	15359	16236	17107	55
14 0	08181	09098	10009	10916	11818	12714	13606	14492	15374	16250	17122	56
15	08196	09113	10025	10931	11833	12729	13621	14507	15389	16265	17136	57
30	08211	09128	10040	10946	11848	12744	13636	14522	15403	16279	17151	58
45	08227	09143	10055	10961	11863	12759	13650	14537	15418	16294	17165	59

Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 15. Parts	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

LOG. SINE SQUARE

	130°	131°				132°				133°		
	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	
	8h 43m	8h 44m	8h 45m	8h 46m	8h 47m	8h 48m	8h 49m	8h 50m	8h 51m	8h 52m	8h 53m	s.
m s	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	
0 0	17180	18046	18907	19763	20614	21460	22302	23138	23969	24794	25617	0
15	17194	18060	18921	19777	20628	21474	22316	23152	23983	24809	25631	1
30	17209	18075	18936	19791	20642	21488	22330	23166	23997	24823	25644	2
45	17223	18089	18950	19806	20657	21502	22343	23179	24011	24837	25658	3
1 0	17238	18103	18964	19820	20671	21516	22357	23193	24024	24850	25672	4
15	17252	18118	18978	19834	20685	21531	22371	23207	24038	24864	25685	5
30	17267	18132	18993	19848	20699	21545	22385	23221	24052	24878	25699	6
45	17281	18147	19007	19863	20713	21559	22399	23235	24066	24892	25713	7
2 0	17296	18161	19021	19877	20727	21573	22413	23249	24079	24905	25726	8
15	17310	18175	19036	19891	20741	21587	22427	23263	24093	24919	25740	9
30	17324	18190	19050	19905	20755	21601	22441	23277	24107	24933	25753	10
45	17339	18204	19064	19919	20770	21615	22455	23291	24121	24947	25767	11
3 0	17353	18218	19079	19934	20784	21629	22469	23304	24134	24960	25781	12
15	17368	18233	19093	19948	20798	21643	22483	23318	24148	24974	25794	13
30	17382	18247	19107	19962	20812	21657	22497	23332	24162	24988	25808	14
45	17397	18262	19121	19976	20826	21671	22511	23346	24176	25001	25822	15
4 0	17411	18276	19136	19990	20840	21685	22525	23360	24190	25015	25835	16
15	17426	18290	19150	20005	20854	21699	22539	23374	24203	25029	25849	17
30	17440	18305	19164	20019	20868	21713	22553	23388	24217	25043	25863	18
45	17454	18319	19179	20033	20883	21727	22567	23402	24231	25056	25876	19
5 0	17469	18333	19193	20047	20897	21741	22581	23415	24245	25070	25890	20
15	17483	18348	19207	20061	20911	21755	22595	23429	24258	25084	25903	21
30	17498	18362	19221	20076	20925	21769	22609	23443	24272	25097	25917	22
45	17512	18376	19236	20090	20939	21783	22623	23457	24286	25111	25931	23
6 0	17527	18391	19250	20104	20953	21797	22637	23471	24299	25125	25944	24
15	17541	18405	19264	20118	20967	21811	22651	23485	24313	25138	25958	25
30	17556	18419	19278	20132	20981	21825	22664	23499	24327	25152	25972	26
45	17570	18434	19293	20147	20995	21839	22678	23512	24341	25166	25985	27
7 0	17585	18448	19307	20161	21010	21853	22692	23526	24354	25180	25999	28
15	17599	18463	19321	20175	21024	21868	22706	23540	24368	25193	26012	29
30	17613	18477	19336	20189	21038	21882	22720	23554	24382	25207	26026	30
45	17628	18491	19350	20203	21052	21896	22734	23568	24396	25221	26040	31
8 0	17642	18506	19364	20218	21066	21910	22748	23582	24410	25234	26053	32
15	17657	18520	19378	20232	21080	21924	22762	23596	24424	25248	26067	33
30	17671	18534	19393	20246	21094	21938	22776	23609	24438	25262	26080	34
45	17686	18549	19407	20260	21108	21952	22790	23623	24452	25275	26094	35
9 0	17700	18563	19421	20274	21122	21966	22804	23637	24466	25289	26108	36
15	17714	18577	19435	20288	21136	21980	22818	23651	24479	25303	26121	37
30	17729	18592	19450	20303	21151	21994	22832	23665	24493	25316	26135	38
45	17743	18606	19464	20317	21165	22008	22846	23679	24507	25330	26148	39
10 0	17758	18620	19478	20331	21179	22022	22860	23693	24521	25344	26162	40
15	17772	18635	19492	20345	21193	22036	22874	23707	24534	25357	26176	41
30	17787	18649	19507	20359	21207	22050	22887	23721	24548	25371	26189	42
45	17801	18663	19521	20373	21221	22064	22901	23735	24562	25385	26203	43
11 0	17815	18678	19535	20388	21235	22078	22915	23749	24576	25398	26216	44
15	17830	18692	19549	20402	21249	22092	22929	23762	24589	25412	26230	45
30	17844	18706	19564	20416	21263	22106	22943	23776	24603	25426	26244	46
45	17859	18721	19578	20430	21278	22120	22957	23790	24617	25439	26257	47
12 0	17873	18735	19592	20444	21292	22134	22971	23804	24631	25453	26271	48
15	17887	18749	19606	20458	21306	22148	22985	23818	24644	25467	26284	49
30	17902	18764	19621	20473	21320	22162	22999	23831	24658	25480	26298	50
45	17916	18778	19635	20487	21334	22176	23013	23845	24672	25494	26311	51
13 0	17931	18792	19649	20501	21348	22190	23027	23859	24686	25508	26325	52
15	17945	18807	19663	20515	21362	22204	23040	23873	24699	25521	26339	53
30	17959	18821	19678	20529	21376	22218	23054	23886	24713	25535	26352	54
45	17974	18835	19692	20543	21390	22232	23068	23900	24727	25549	26366	55
14 0	17988	18850	19706	20558	21404	22246	23082	23914	24740	25562	26379	56
15	18003	18864	19720	20572	21418	22260	23096	23928	24754	25576	26393	57
30	18017	18878	19735	20586	21432	22274	23110	23942	24768	25590	26407	58
45	18031	18893	19749	20600	21446	22288	23124	23955	24782	25603	26420	59

Sec.	1″	2	3	4	5	6″	7″	8″	9″	10	11″	12″	13	14″	15″
D 14 Parts	1	2	3	4	5	6	7	7	8	9	10	11	12	13	14

LOG. SINE SQUARE

	133°		134°				135°				136°	
	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	
	8h 54m	8h 55m	8h 56m	8h 57m	8h 58m	8h 59m	9h 0m	9h 1m	9h 2m	9h 3m	9h 4m	s.
′ ″	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	
0 0	26434	27245	28052	28854	29651	30443	31231	32013	32791	33564	34332	0
15	26447	27259	28066	28867	29664	30457	31244	32026	32804	33576	34345	1
30	26461	27272	28079	28881	29678	30470	31257	32039	32817	33589	34357	2
45	26474	27286	28092	28894	29691	30483	31270	32052	32830	33602	34370	3
1 0	26488	27299	28106	28907	29704	30496	31283	32065	32842	33615	34383	4
15	26501	27313	28119	28921	29717	30509	31296	32078	32855	33628	34396	5
30	26515	27326	28133	28934	29731	30522	31309	32091	32868	33641	34408	6
45	26529	27340	28146	28947	29744	30535	31322	32104	32881	33653	34421	7
2 0	26542	27353	28159	28961	29757	30549	31335	32117	32894	33666	34434	8
15	26556	27367	28173	28974	29770	30562	31348	32130	32907	33679	34447	9
30	26569	27380	28186	28987	29783	30575	31361	32143	32920	33692	34459	10
45	26583	27394	28199	29000	29797	30588	31374	32156	32933	33705	34472	11
3 0	26596	27407	28213	29014	29810	30601	31388	32169	32946	33718	34485	12
15	26610	27421	28226	29027	29823	30614	31401	32182	32959	33730	34498	13
30	26623	27434	28240	29040	29836	30627	31414	32195	32972	33743	34510	14
45	26637	27448	28253	29054	29850	30641	31427	32208	32984	33756	34523	15
4 0	26651	27461	28266	29067	29863	30654	31440	32221	32997	33769	34536	16
15	26664	27474	28280	29080	29876	30667	31453	32234	33010	33782	34549	17
30	26678	27488	28293	29094	29889	30680	31466	32247	33023	33795	34561	18
45	26691	27501	28307	29107	29902	30693	31479	32260	33036	33807	34574	19
5 0	26705	27515	28320	29120	29916	30706	31492	32273	33049	33820	34587	20
15	26718	27528	28333	29134	29929	30719	31505	32286	33062	33833	34599	21
30	26732	27542	28347	29147	29942	30733	31518	32299	33075	33846	34612	22
45	26745	27555	28360	29160	29955	30746	31531	32312	33088	33859	34625	23
6 0	26759	27569	28374	29173	29969	30759	31544	32325	33100	33871	34638	24
15	26772	27582	28387	29187	29982	30772	31557	32338	33113	33884	34650	25
30	26786	27596	28400	29200	29995	30785	31570	32351	33126	33897	34663	26
45	26800	27609	28414	29213	30008	30798	31583	32364	33139	33910	34676	27
7 0	26813	27622	28427	29227	30021	30811	31596	32377	33152	33923	34688	28
15	26827	27636	28440	29240	30035	30825	31609	32390	33165	33936	34701	29
30	26840	27649	28454	29253	30048	30838	31622	32403	33178	33948	34714	30
45	26854	27663	28467	29266	30061	30851	31636	32416	33191	33961	34727	31
8 0	26867	27676	28480	29280	30074	30864	31649	32429	33204	33974	34739	32
15	26881	27690	28494	29293	30087	30877	31662	32441	33216	33987	34752	33
30	26894	27703	28507	29306	30101	30890	31675	32454	33229	34000	34765	34
45	26908	27716	28520	29320	30114	30903	31688	32467	33242	34012	34777	35
9 0	26921	27730	28534	29333	30127	30916	31701	32480	33255	34025	34790	36
15	26935	27743	28547	29346	30140	30929	31714	32493	33268	34038	34803	37
30	26948	27757	28561	29359	30153	30943	31727	32506	33281	34051	34816	38
45	26962	27770	28574	29373	30167	30956	31740	32519	33294	34063	34828	39
10 0	26975	27784	28587	29386	30180	30969	31753	32532	33307	34076	34841	40
15	26989	27797	28601	29399	30193	30982	31766	32545	33319	34089	34854	41
30	27002	27811	28614	29413	30206	30995	31779	32558	33332	34102	34866	42
45	27016	27824	28627	29426	30219	31008	31792	32571	33345	34115	34879	43
11 0	27029	27837	28641	29439	30233	31021	31805	32584	33358	34127	34892	44
15	27043	27851	28654	29452	30246	31034	31818	32597	33371	34140	34905	45
30	27056	27864	28667	29466	30259	31047	31831	32610	33384	34153	34917	46
45	27070	27878	28681	29479	30272	31060	31844	32623	33397	34166	34930	47
12 0	27083	27891	28694	29492	30285	31074	31857	32636	33409	34178	34943	48
15	27097	27905	28707	29505	30298	31087	31870	32649	33422	34191	34955	49
30	27110	27918	28721	29519	30312	31100	31883	32662	33435	34204	34968	50
45	27124	27931	28734	29532	30325	31113	31896	32674	33448	34217	34981	51
13 0	27137	27945	28747	29545	30338	31126	31909	32687	33461	34230	34993	52
15	27151	27958	28761	29558	30351	31139	31922	32700	33474	34242	35006	53
30	27164	27972	28774	29572	30364	31152	31935	32713	33487	34255	35019	54
45	27178	27985	28787	29585	30377	31165	31948	32726	33500	34268	35031	55
14 0	27191	27999	28801	29598	30391	31178	31961	32739	33512	34281	35044	56
15	27205	28012	28814	29611	30404	31191	31974	32752	33525	34293	35057	57
30	27218	28025	28827	29625	30417	31204	31987	32765	33538	34306	35070	58
45	27232	28039	28841	29638	30430	31218	32000	32778	33551	34319	35082	59

	Sec.	1	2	3	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 13.	Parts	1	2	3	3	4	5	6	7	8	9	10	10	11	12	13

LOG. SINE SQUARE

	136°			137°				138°				
	15′	30	45′	0′	15′	30′	45′	0′	15′	30	45′	
′ ″	9h 5m	9h 6m	9h 7m	9h 8m	9h 9m	9h 10m	9h 11m	9h 12m	9h 13m	9h 14m	9h 15m	s.
	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	
0 0	35095	35853	36607	37356	38100	38839	39574	40303	41029	41749	42464	0
15	35108	35866	36620	37368	38112	38851	39586	40316	41041	41761	42476	1
30	35120	35879	36632	37381	38125	38864	39598	40328	41053	41773	42488	2
45	35133	35891	36645	37393	38137	38876	39610	40340	41065	41785	42500	3
1 0	35146	35904	36657	37405	38149	38888	39622	40352	41077	41797	42512	4
15	35158	35916	36670	37418	38162	38901	39635	40364	41089	41809	42524	5
30	35171	35929	36682	37430	38174	38913	39647	40376	41101	41821	42536	6
45	35184	35942	36695	37443	38186	38925	39659	40388	41113	41833	42548	7
2 0	35196	35954	36707	37455	38199	38937	39671	40400	41125	41844	42559	8
15	35209	35967	36720	37468	38211	38950	39683	40413	41137	41856	42571	9
30	35222	35979	36732	37480	38223	38962	39696	40425	41149	41868	42583	10
45	35234	35992	36745	37493	38236	38974	39708	40437	41161	41880	42595	11
3 0	35247	36004	36757	37505	38248	38986	39720	40449	41173	41892	42607	12
15	35260	36017	36770	37517	38261	38999	39732	40461	41185	41904	42619	13
30	35272	36030	36782	37530	38273	39011	39744	40473	41197	41916	42631	14
45	35285	36042	36795	37542	38285	39023	39757	40485	41209	41928	42643	15
4 0	35298	36055	36807	57555	38297	39035	39769	40497	41221	41940	42654	16
15	35310	36067	36820	37567	38310	39048	39781	40509	41233	41952	42666	17
30	35323	36080	36832	37579	38322	39060	39793	40521	41245	41964	42678	18
45	35336	36092	36845	37592	38334	39072	39805	40534	41257	41976	42690	19
5 0	35348	36105	36857	37604	38347	39084	39817	40546	41269	41988	42702	20
15	35361	36118	36870	37617	38359	39097	39830	40558	41281	42000	42714	21
30	35373	36130	36882	37629	38371	39109	39842	40570	41293	42012	42726	22
45	35386	36143	36895	37642	38384	39121	39854	40582	41305	42024	42737	23
6 0	35399	36155	36907	37654	38396	39134	39866	40594	41317	42036	42749	24
15	35411	36168	36920	37666	38408	39146	39878	40606	41329	42048	42761	25
30	35424	36180	36932	37679	38421	39158	39890	40618	41341	42059	42773	26
45	35437	36193	36945	37691	38433	39170	39903	40630	41353	42071	42785	27
7 0	35449	36206	36957	37704	38445	39183	39915	40642	41365	42083	42797	28
15	35462	36218	36969	37716	38458	39195	39927	40654	41377	42095	42809	29
30	35475	36231	36982	37728	38470	39207	39939	40667	41389	42107	42820	30
45	35487	36243	36994	37741	38482	39219	39951	40679	41401	42119	42832	31
8 0	35500	36256	37007	37753	38495	39232	39963	40691	41413	42131	42844	32
15	35513	36268	37019	37766	38507	39244	39976	40703	41425	42143	42856	33
30	35525	36281	37032	37778	38519	39256	39988	40715	41437	42155	42868	34
45	35538	36294	37044	37790	38532	39268	40000	40727	41449	42167	42880	35
9 0	35551	36306	37057	37803	38544	39280	40012	40739	41461	42179	42891	36
15	35563	36319	37069	37815	38556	39293	40024	40751	41473	42191	42903	37
30	35576	36331	37082	37828	38569	39305	40036	40763	41485	42203	42915	38
45	35588	36344	37094	37840	38581	39317	40049	40775	41497	42214	42927	39
10 0	35601	36356	37107	37852	38593	39329	40061	40787	41509	42226	42939	40
15	35614	36369	37119	37865	38606	39342	40073	40799	41521	42238	42951	41
30	35626	36381	37132	37877	38618	39354	40085	40811	41533	42250	42963	42
45	35639	36394	37144	37890	38630	39366	40097	40824	41545	42262	42974	43
11 0	35652	36406	37157	37902	38642	39378	40109	40836	41557	42274	42986	44
15	35664	36419	37169	37914	38655	39390	40121	40848	41569	42286	42998	45
30	35677	36431	37181	37927	38667	39403	40134	40860	41581	42298	43010	46
45	35689	36444	37194	37939	38679	39415	40146	40872	41593	42310	43022	47
12 0	35702	36457	37206	37951	38692	39427	40158	40884	41605	42322	43033	48
15	35715	36469	37219	37964	38704	39439	40170	40896	41617	42334	43045	49
30	35727	36482	37231	37976	38716	39452	40182	40908	41629	42345	43057	50
45	35740	36494	37244	37989	38729	39464	40194	40920	41641	42357	43069	51
13 0	35753	36507	37256	38001	38741	39476	40206	40932	41653	42369	43081	52
15	35765	36519	37269	38013	38753	39488	40219	40944	41665	42381	43093	53
30	35778	36532	37281	38026	38765	39500	40231	40956	41677	42393	43104	54
45	35790	36544	37294	38038	38778	39513	40243	40968	41689	42405	43116	55
14 0	35803	36557	37306	38050	38790	39525	40255	40980	41701	42417	43128	56
15	35816	36569	37318	38063	38802	39537	40267	40992	41713	42429	43140	57
30	35828	36582	37331	38075	38815	39549	40279	41004	41725	42441	43152	58
45	35841	36594	37343	38087	38827	39561	40291	41016	41737	42452	43163	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″
D. 12.	Parts	1	2	2	3	4	5	6	6	7	8	9	10	11	12

LOG. SINE SQUARE

	139°				140°				141°			
	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	30	
	9h 16m	9h 17m	9h 18m	9h 19m	9h 20m	9h 21m	9h 22m	9h 23m	9h 24m	9h 25m	9h 26m	s.
′ ″	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	
0 0	43175	43881	44583	45280	45972	46659	47342	48020	48693	49362	50026	0
15	43187	43893	44594	45291	45983	46670	47353	48031	48704	49373	50037	1
30	43199	43905	44606	45303	45995	46682	47364	48042	48716	49384	50048	2
45	43211	43917	44618	45314	46006	46693	47376	48054	48727	49395	50059	3
1 0	43222	43928	44629	45326	46018	46705	47387	48065	48738	49406	50070	4
15	43234	43940	44641	45337	46029	46716	47398	48076	48749	49417	50081	5
30	43246	43952	44653	45349	46041	46727	47410	48087	48760	49428	50092	6
45	43258	43963	44664	45361	46052	46739	47421	48099	48771	49439	50103	7
2 0	43270	43975	44676	45372	46064	46750	47432	48110	48782	49451	50114	8
15	43281	43987	44688	45384	46075	46762	47444	48121	48794	49462	50125	9
30	43293	43999	44699	45395	46086	46773	47455	48132	48805	49473	50136	10
45	43305	44010	44711	45407	46098	46785	47466	48144	48816	49484	50147	11
3 0	43317	44022	44723	45418	46109	46796	47478	48155	48827	49495	50158	12
15	43329	44034	44734	45430	46121	46807	47489	48166	48838	49506	50169	13
30	43340	44045	44746	45441	46132	46819	47500	48177	48849	49517	50180	14
45	43352	44057	44757	45453	46144	46830	47512	48189	48861	49528	50191	15
4 0	43364	44069	44769	45465	46155	46842	47523	48200	48872	49539	50202	16
15	43376	44081	44781	45476	46167	46853	47534	48211	48883	49550	50213	17
30	43388	44092	44792	45488	46178	46864	47546	48222	48894	49561	50224	18
45	43399	44104	44804	45499	46190	46876	47557	48233	48905	49573	50235	19
5 0	43411	44116	44816	45511	46201	46887	47568	48245	48916	49584	50246	20
15	43423	44127	44827	45522	46213	46898	47579	48256	48928	49595	50257	21
30	43435	44139	44839	45534	46224	46910	47591	48267	48939	49606	50268	22
45	43446	44151	44850	45545	46236	46921	47602	48278	48950	49617	50279	23
6 0	43458	44162	44862	45557	46247	46933	47613	48290	48961	49628	50290	24
15	43470	44174	44874	45569	46259	46944	47625	48301	48972	49639	50301	25
30	43482	44186	44885	45580	46270	46955	47636	48312	48983	49650	50312	26
45	43494	44198	44897	45592	46281	46967	47647	48323	48995	49661	50323	27
7 0	43505	44209	44909	45603	46293	46978	47659	48335	49006	49672	50334	28
15	43517	44221	44920	45615	46304	46990	47670	48346	49017	49684	50345	29
30	43529	44233	44932	45626	46316	47001	47681	48357	49028	49694	50356	30
45	43541	44244	44943	55638	46327	47012	47693	48368	49039	49705	50367	31
8 0	43552	44256	44955	45649	46339	47024	47704	48379	49050	49716	50378	32
15	43564	44268	44967	45661	46350	47035	47715	48391	49062	49728	50389	33
30	43576	44279	44978	45672	46362	47046	47726	48402	49073	49739	50400	34
45	43588	44291	44990	45684	46373	47058	47738	48413	49084	49750	50411	35
9 0	43599	44303	45001	45695	46385	47069	47749	48424	49095	49761	50422	36
15	43611	44314	45013	45707	46396	47081	47760	48436	49106	49772	50433	37
30	43623	44326	45025	45718	46407	47092	47772	48447	49117	49783	50444	38
45	43635	44338	45036	45730	46419	47103	47783	48458	49128	49794	50455	39
10 0	43647	44350	45048	45741	46430	47115	47794	48469	49139	49805	50466	40
15	43658	44361	45059	45753	46442	47126	47805	48480	49151	49816	50477	41
30	43670	44373	45071	45765	46453	47137	47817	48492	49162	49827	50488	42
45	43682	44385	45083	45776	46465	47149	47828	48503	49173	49838	50499	43
11 0	43694	44396	45094	45788	46476	47160	47839	48514	49184	49849	50510	44
15	43705	44408	45106	45799	46488	47171	47851	48525	49195	49860	50521	45
30	43717	44420	45117	45811	46499	47183	47862	48536	49206	49871	50532	46
45	43729	44431	45129	45822	46510	47194	47874	48548	49217	49882	50543	47
12 0	43741	44443	45141	45834	46522	47206	47884	48559	49228	49893	50554	48
15	43752	44455	45152	45845	46533	47217	47896	48570	49240	49904	50565	49
30	43764	44466	45164	45857	46545	47228	47907	48581	49251	49916	50576	50
45	43776	44478	45175	45868	46556	47240	47918	48592	49262	49927	50587	51
13 0	43787	44490	45187	45880	46568	47251	47930	48604	49273	49938	50598	52
15	43799	44501	45199	45891	46579	47262	47941	48615	49284	49949	50609	53
30	43811	44513	45210	45903	46591	47274	47952	48626	49295	49960	50620	54
45	43823	44525	45222	45914	46602	47285	47963	48637	49306	49971	50631	55
14 0	43834	44536	45233	45926	46613	47296	47975	48648	49317	49982	50642	56
15	43846	44548	45245	45937	46625	47308	47986	48660	49328	49993	50653	57
30	43858	44560	45256	45949	46636	47319	47997	48671	49340	50004	50663	58
45	43870	44571	45268	45960	46648	47330	48008	48682	49351	50015	50674	59

Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 11. Parts	1	1	2	3	4	4	5	6	7	7	8	9	9	10	11

LOG. SINE SQUARE

	141°	142°				143°				144°		
	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	
	9h 27m	9h 28m	9h 29m	9h 30m	9h 31m	9h 32m	9h 33m	9h 34m	9h 35m	9h 36m	9h 37m	s.
′ ″	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	
0 0	50685	51340	51990	52636	53277	53913	54545	55172	55795	56413	57026	0
15	50696	51351	52001	52647	53287	53924	54555	55182	55805	56423	57036	1
30	50707	51362	52012	52657	53298	53934	54566	55193	55815	56433	57046	2
45	50718	51373	52023	52668	53309	53945	54576	55203	55826	56443	57057	3
1 0	50729	51384	52034	52679	53319	53955	54587	55214	55836	56454	57067	4
15	50740	51395	52045	52689	53330	53966	54597	55224	55846	56464	57077	5
30	50751	51405	52055	52700	53341	53977	54608	55235	55857	56474	57087	6
45	50762	51416	52066	52711	53351	53987	54618	55245	55867	56484	57097	7
2 0	50773	51427	52077	52722	53362	53998	54629	55255	55877	56495	57107	8
15	50784	51438	52087	52732	53372	54008	54639	55266	55888	56505	57118	9
30	50795	51449	52098	52743	53383	54019	54650	55276	55898	56515	57128	10
45	50806	51460	52109	52754	53394	54029	54660	55287	55908	56525	57138	11
3 0	50817	51471	52120	52764	53404	54040	54671	55297	55919	56536	57148	12
15	50828	51481	52131	52775	53415	54050	54681	55307	55929	56546	57158	13
30	50838	51492	52141	52786	54425	54061	54692	55318	55939	56556	57169	14
45	50849	51503	52152	52796	53436	54071	54702	55328	55950	56566	57179	15
4 0	50860	51514	52163	52807	53447	54082	54713	55339	55960	56577	57189	16
15	50871	51525	52174	52818	53457	54093	54723	55349	55970	56587	57199	17
30	50882	51536	52184	52829	53468	54103	54734	55359	55981	56597	57209	18
45	50893	51547	52195	52839	53479	54114	54744	55370	55991	56607	57219	19
5 0	50904	51557	52206	52850	53489	54124	54754	55380	56001	56618	57229	20
15	50915	51568	52217	52861	53500	54135	54765	55390	56011	56628	57240	21
30	50926	51579	52228	52871	53511	54145	54775	55401	56022	56638	57250	22
45	50937	51590	52238	52882	53521	54156	54786	55411	56032	56648	57260	23
6 0	50948	51601	52249	52893	53532	54166	54796	55422	56042	56659	57270	24
15	50959	51612	52260	52903	53542	54177	54807	55432	56053	56669	57280	25
30	50970	51622	52271	52914	53553	54187	54817	55442	56063	56679	57290	26
45	50980	51633	52281	52925	53564	54198	54828	55453	56073	56689	57301	27
7 0	50991	51644	52292	52936	53574	54209	54838	55463	56084	56699	57311	28
15	51002	51655	52303	52946	53585	54219	54849	55473	56094	56710	57321	29
30	51013	51666	52314	52957	53596	54230	54859	55484	56104	56720	57331	30
45	51024	51677	52324	52968	53606	54240	54870	55494	56114	56730	57341	31
8 0	51035	51687	52335	52978	53617	54251	54880	55505	56125	56740	57351	32
15	51046	51698	52346	52989	53627	54261	54890	55515	56135	56751	57362	33
30	51057	51709	52357	53000	53638	54272	54901	55525	56145	56761	57372	34
45	51068	51720	52367	53010	53649	54282	54911	55536	56156	56771	57382	35
9 0	51079	51731	52378	53021	53659	54293	54922	55546	56166	56781	57392	36
15	51090	51742	52389	53032	53670	54303	54932	55556	56176	56791	57402	37
30	51101	51752	52400	53042	53680	54314	54943	55567	56187	56802	57412	38
45	51111	51763	52410	53053	53691	54324	54953	55577	56197	56812	57422	39
10 0	51122	51774	52421	53064	53702	54335	54964	55588	56207	56822	57433	40
15	51133	51785	52432	53074	53712	54345	54974	55598	56217	56832	57443	41
30	51144	51796	52443	53085	53723	54356	54984	55608	56228	56842	57453	42
45	51155	51806	52453	53096	53733	54366	54995	55619	56238	56853	57463	43
11 0	51166	51817	52464	53106	53744	54377	55005	55629	56248	56863	57473	44
15	51177	51828	52475	53117	53755	54387	55016	55639	56258	56873	57483	45
30	51188	51839	52486	53128	53765	54398	55026	55650	56269	56883	57493	46
45	51199	51850	52496	53138	53776	54408	55037	55660	56279	56894	57503	47
12 0	51210	51861	52507	53149	53786	54419	55047	55670	56289	56904	57513	48
15	51220	51871	52518	53160	53797	54429	55057	55681	56300	56914	57524	49
30	51231	51882	52529	53170	53807	54440	55068	55691	56310	56924	57534	50
45	51242	51893	52539	53181	53818	54450	55078	55701	56320	56934	57544	51
13 0	51253	51904	52550	53192	53829	54461	55089	55712	56330	56945	57554	52
15	51264	51915	52561	53202	53839	54471	55099	55722	56341	56955	57564	53
30	51275	51926	52571	53213	53850	54482	55110	55733	56351	56965	57574	54
45	51286	51936	52582	53224	53860	54492	55120	55743	56361	56975	57584	55
14 0	51297	51947	52593	53234	53871	54503	55130	55753	56371	56985	57594	56
15	51308	51958	52604	53245	53881	54513	55141	55764	56382	56996	57605	57
30	51318	51069	52614	53256	53892	54524	55151	55774	56392	57006	57615	58
45	51329	51980	52625	53266	53903	54534	55162	55784	56402	57016	57625	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D 10.	Parts	1	1	2	3	3	4	5	5	6	7	7	8	9	9	10

LOG. SINE SQUARE

	144°		145°				146°				147°	
	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	
′ ″	9h 38m	9h 39m	9h 40m	9h 41m	9h 42m	9h 43m	9h 44m	9h 45m	9h 46m	9h 47m	9h 48m	s.
	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	
0 0	57635	58239	58839	59434	60025	60611	61193	61770	62342	62910	63474	0
15	57645	58249	58849	59444	60035	60621	61202	61779	62352	62920	63483	1
30	57655	58259	58859	59454	60044	60630	61212	61789	62361	62929	63493	2
45	57665	58269	58869	59464	60054	60640	61222	61798	62371	62939	63502	3
1 0	57675	58279	58879	59474	60064	60650	61231	61808	62380	62948	63511	4
15	57685	58289	58889	59484	60074	60660	61241	61818	62390	62957	63521	5
30	57696	58299	58899	59493	60084	60669	61250	61827	62399	62967	63530	6
45	57706	58309	58909	59503	60093	60679	61260	61837	62409	62976	63539	7
2 0	57716	58319	58919	59513	60103	60689	61270	61846	62418	62986	63549	8
15	57726	58329	58929	59523	60113	60699	61279	61856	62428	62995	63558	9
30	57736	58340	58938	59533	60123	60708	61289	61865	62437	63005	63567	10
45	57746	58350	58948	59543	60133	60718	61299	61875	62447	63014	63577	11
3 0	57756	58360	58958	59553	60142	60728	61308	61885	62456	63023	63586	12
15	57766	58370	58968	59563	60152	60737	61318	61894	62466	63033	63595	13
30	57776	58380	58978	59572	60162	60747	61328	61904	62475	63042	63605	14
45	57786	58390	58988	59582	60172	60757	61337	61913	62485	63052	63614	15
4 0	57797	58400	58998	59592	60182	60767	61347	61923	62494	63061	63623	16
15	57807	58410	59008	59602	60191	60776	61357	61932	62504	63070	63633	17
30	57817	58420	59018	59612	60201	60786	61366	61942	62513	63080	63642	18
45	57827	58430	59028	59622	60211	60796	61376	61951	62523	63089	63651	19
5 0	57837	58440	59038	59632	60221	60805	61385	61961	62532	63059	63661	20
15	57847	58450	59048	59641	60230	60815	61395	61970	62542	63108	63670	21
30	57857	58460	59058	59651	60240	60825	61405	61980	62551	63118	63679	22
45	57867	58470	59068	59661	60250	60834	61414	61990	62561	63127	63689	23
6 0	57877	58480	59078	59671	60260	60844	61424	61999	62570	63136	63698	24
15	57887	58490	59088	59681	60270	60854	61434	62009	62579	63146	63707	25
30	57897	58500	59097	59691	60279	60864	61443	62018	62589	63155	63717	26
45	57907	58510	59107	59701	60289	60873	61453	62028	62598	63165	63726	27
7 0	57917	58520	59117	59710	60299	60883	61462	62037	62608	63174	63735	28
15	57928	58530	59127	59720	60309	60893	61472	62047	62617	63183	63745	29
30	57938	58540	59137	59730	60318	60902	61482	62057	62627	63193	63754	30
45	57948	58550	59147	59740	60328	60912	61491	62066	62636	63202	63763	31
8 0	57958	58560	59157	59750	60338	60922	61501	62076	62646	63211	63773	32
15	57968	58570	59167	59760	60348	60931	61511	62085	62655	63221	63782	33
30	57978	58580	59177	59769	60357	60941	61520	62095	62665	63230	63791	34
45	57988	58590	59187	59779	60367	60951	61530	62104	62674	63240	63801	35
9 0	57998	58600	59197	59789	60377	60960	61539	62114	62684	63249	63810	36
15	58008	58610	59207	59799	60387	60970	61549	62123	62693	63258	63819	37
30	58018	58620	59216	59809	60396	60980	61559	62133	62703	63268	63828	38
45	58028	58630	59226	59819	60406	60990	61568	62142	62712	63277	63838	39
10 0	58038	58640	59236	59828	60416	60999	61578	62152	62721	63287	63847	40
15	58048	58650	59246	59838	60426	61009	61587	62161	62731	63296	63856	41
30	58058	58660	59256	59848	60436	61019	61597	62171	62740	63305	63866	42
45	58068	58670	59266	59858	60445	61028	61607	62180	62750	63315	63875	43
11 0	58078	58680	59276	59868	60455	61038	61616	62190	62759	63324	63884	44
15	58089	58690	59286	59878	60465	61048	61626	62200	62769	63333	63894	45
30	58099	58700	59296	59887	60475	61057	61635	62209	62778	63343	63903	46
45	58109	58709	59306	59897	60484	61067	61645	62219	62788	63352	63912	47
12 0	58119	58719	59315	59907	60494	61077	61655	62228	62797	63362	63922	48
15	58129	58729	59325	59917	60504	61086	61664	62238	62807	63371	63931	49
30	58139	58739	59335	59927	60514	61096	61674	62247	62816	63380	63940	50
45	58149	58749	59345	59937	60523	61106	61683	62257	62825	63390	63949	51
13 0	58159	58759	59355	59946	60533	61115	61693	62266	62835	63399	63959	52
15	58169	58769	59365	59956	60543	61125	61703	62276	62844	63408	63968	53
30	58179	58779	59375	59966	60553	61135	61712	62285	62854	63418	63977	64
45	58189	58789	59385	59976	60562	61144	61722	62295	62863	63427	63987	55
14 0	58199	58799	59395	59986	60572	61154	61731	62304	62873	63436	63996	56
15	58209	58809	59405	59995	60582	61164	61741	62314	62882	63446	64005	57
30	58219	58819	59414	60005	60591	61173	61751	62323	62891	63455	64014	58
45	58229	58829	59424	60015	60601	61183	61760	62333	62901	63465	64024	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 10.	Parts	1	1	2	3	3	4	5	5	6	7	7	8	9	9	10

LOG. SINE SQUARE

	147°			148°				149°				
	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	
′ ″	9h 49m	9h 50m	9h 51m	9h 52m	9h 53m	9h 54m	9h 55m	9h 56m	9h 57m	9h 58m	9h 59m	s.
	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	
0 0	64033	64588	65138	65683	66224	66761	67293	67821	68344	68863	69378	0
15	64042	64597	65147	65692	66233	66770	67302	67830	68353	68872	69386	1
30	64052	64606	65156	65701	66242	66779	67311	67839	68362	68880	69395	2
45	64061	64615	65165	65710	66251	66788	67320	67847	68370	68889	69403	3
1 0	64070	64624	65174	65719	66260	66797	67329	67856	68379	68898	69412	4
15	64079	64634	65183	65729	66269	66806	67337	67865	68388	68906	69420	5
30	64089	64643	65192	65738	66278	66814	67346	67874	68396	68915	69429	6
45	64099	64652	65202	65747	66287	66823	67355	67882	68405	68923	69437	7
2 0	64107	64661	65211	65756	66296	66832	67364	67891	68414	68932	69446	8
15	64116	64670	65220	65765	66305	66841	67373	67900	68423	68941	69454	9
30	64126	64680	65229	65774	66314	66850	67382	67909	68431	68949	69463	10
45	64135	64689	65238	65783	66323	66859	67390	67917	68440	68958	69471	11
3 0	64144	64698	65247	65792	66332	66868	67399	67926	68448	68966	69480	12
15	64154	64707	65256	65801	66341	66877	67408	67935	68457	68975	69488	13
30	64163	64716	65265	65810	66350	66886	67417	67943	68466	68984	69497	14
45	64172	64726	65274	65819	66359	66895	67426	67952	68474	68992	69506	15
4 0	64181	64735	65284	65828	66368	66903	67434	67961	68483	69001	69514	16
15	64191	64744	65293	65837	66377	66912	67443	67970	68492	69009	69523	17
30	64200	64753	65302	65846	66386	66921	67452	67978	68500	69018	69531	18
45	64209	64762	65311	65855	66395	66930	67461	67987	68509	69027	69540	19
5 0	64218	64771	65320	65864	66404	66939	67470	67996	68518	69035	69548	20
15	64228	64781	65329	65873	66413	66948	67479	68005	68526	69044	69557	21
30	64237	64790	65338	65882	66422	66957	67487	68013	68535	69052	69565	22
45	64246	64799	65347	65891	66431	66966	67496	68022	68544	69061	69574	23
6 0	64255	64808	65356	65900	66440	66974	67505	68031	68552	69069	69582	24
15	64265	64817	65366	65909	66449	66983	67514	68040	68561	69078	69591	25
30	64274	64827	65375	65918	66458	66992	67523	68048	68570	69087	69599	26
45	64283	64836	65384	65927	66466	67001	67531	68057	68578	69095	69608	27
7 0	64292	64845	65393	65936	66475	67010	67540	68066	68587	69104	69616	28
15	64302	64854	65402	65945	66484	67019	67549	68074	68596	69112	69625	29
30	64311	64863	65411	65954	66493	67028	67558	68083	68604	69121	69633	30
45	64320	64873	65420	65963	66502	67037	67567	68092	68613	69129	69642	31
8 0	64329	64882	65429	65972	66511	67045	67575	68101	68622	69138	69650	32
15	64339	64891	65438	65981	66520	67054	67584	68109	68630	69147	69659	33
30	64348	64900	65447	65990	66529	67063	67593	68118	68639	69155	69667	34
45	64357	64909	65456	65999	66538	67072	67602	68127	68648	69164	69676	35
9 0	64366	64918	65466	66008	66547	67081	67610	68136	68656	69172	69684	36
15	64375	64927	65475	66018	66556	67090	67619	68144	68665	69181	69693	37
30	64385	64936	65484	66027	66565	67099	67628	68153	68673	69189	69701	38
45	64394	64946	65493	66035	66574	67108	67637	68162	68682	69198	69710	39
10 0	64403	64955	65502	66044	66583	67116	67646	68170	68691	69206	69718	40
15	64413	64964	65511	66054	66592	67125	67654	68179	68699	69215	69727	41
30	64422	64973	65520	66063	66601	67134	67663	68188	68708	69224	69735	42
45	64431	64982	65529	66072	66609	67143	67672	68196	68717	69232	69744	43
11 0	64440	64991	65538	66081	66618	67152	67681	68205	68725	69241	69752	44
15	64449	65001	65547	66089	66627	67161	67690	68214	68734	69249	69760	45
30	64459	65010	65556	66098	66636	67169	67698	68223	68742	69258	69769	46
45	64468	65019	65565	66108	66645	67178	67707	68231	68751	69266	69777	47
12 0	64477	65028	65575	66117	66654	67187	67716	68240	68760	69275	69786	48
15	64486	65037	65584	66126	66663	67196	67725	68249	68768	69284	69794	49
30	64495	65046	65593	66135	66672	67205	67733	68257	68777	69292	69803	50
45	64505	65055	65602	66144	66681	67214	67742	68266	68786	69301	69811	51
13 0	64514	65065	65611	66153	66690	67223	67751	68275	68794	69309	69820	52
15	64523	65074	65620	66162	66699	67231	67760	68283	68803	69318	69828	53
30	64532	65083	65629	66170	66708	67240	67768	68292	68811	69326	69837	54
45	64542	65092	65638	66179	66717	67249	67777	68301	68820	69335	69845	55
14 0	64551	65101	65647	66188	66725	67258	67786	68310	68829	69343	69854	56
15	64560	65110	65656	66197	66734	67267	67795	68318	68837	69352	69862	57
30	64569	65119	65665	66206	66743	67276	67803	68327	68846	69360	69871	58
45	64578	65129	65674	66215	66752	67284	67812	68336	68855	69369	69879	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 9	Parts	1	1	2	2	3	4	4	5	5	6	7	7	8	8	9

LOG. SINE SQUARE

	150°				151°				152°			
	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	
	10h 0m	10h 1m	10h 2m	10h 3m	10h 4m	10h 5m	10h 6m	10h 7m	10h 8m	10h 9m	10h 10m	t.
′ ″	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	
0 0	69888	70393	70894	71391	71883	72371	72855	73334	73808	74279	74744	0
15	69896	70401	70902	71399	71891	72379	72863	73342	73816	74286	74752	1
30	69905	70410	70911	71408	71900	72387	72871	73349	73824	74294	74760	2
45	69913	70418	70919	71416	71908	72395	72879	73357	73832	74302	74768	3
1 0	69921	70427	70927	71424	71916	72403	72887	73365	73840	74310	74775	4
15	69930	70435	70936	71432	71924	72411	72895	73373	73848	74318	74783	5
30	69938	70443	70944	71440	71932	72420	72903	73381	73855	74325	74791	6
45	69947	70452	70952	71449	71940	72428	72911	73389	73863	74333	74798	7
2 0	69955	70460	70961	71457	71949	72436	72919	73397	73871	74341	74806	8
15	69964	70469	70969	71465	71957	72444	72927	73405	73879	74349	74814	9
30	69972	70477	70977	71473	71965	72452	72935	73413	73887	74356	74822	10
45	69981	70485	70986	71487	71973	72460	72943	73421	73895	74364	74829	11
3 0	69989	70494	70994	71489	71981	72468	72951	73429	73903	74372	74837	12
15	69997	70502	71002	71497	71989	72476	72959	73437	73910	74380	74845	13
30	70006	70510	71010	71506	71997	72484	72967	73445	73918	74388	74852	14
45	70014	70519	71019	71514	72006	72492	72975	73453	73926	74395	74860	15
4 0	70023	70527	71027	71522	72014	72500	72983	73461	73934	74403	74868	16
15	70031	70535	71035	71531	72022	72508	72991	73468	73942	74411	74876	17
30	70040	70544	71044	71539	72030	72516	72999	73476	73950	74419	74883	18
45	70048	70552	71052	71547	72038	72525	73007	73484	73958	74426	74891	19
5 0	70057	70561	71060	71555	72046	72533	73015	73492	73965	74434	74899	20
15	70065	70569	71069	71564	72054	72541	73023	73500	73973	74442	74906	21
30	70073	70577	71077	71572	72063	72549	73031	73508	73981	74450	74914	22
45	70082	70586	71085	71580	72071	72557	73039	73516	73989	74458	74922	23
6 0	70090	70594	71093	71588	72079	72565	73047	73524	73997	74465	74929	24
15	70099	70602	71102	71597	72087	72573	73055	73532	74005	74473	74937	25
30	70107	70611	71110	71605	72095	72581	73063	73540	74013	74481	74945	26
45	70116	70619	71118	71613	72103	72589	73071	73548	74020	74489	749[illegible]3	27
7 0	70124	70627	71126	71621	72111	72597	73079	73556	74028	74496	74960	28
15	70132	70636	71135	71629	72120	72605	73087	73563	74036	74504	74968	29
30	70141	70644	71143	71638	72128	72613	73095	73571	74044	74512	74976	30
45	70149	70653	71151	71646	72136	72621	73103	73579	74052	74520	74983	31
8 0	70158	70661	71160	71654	72144	72629	73111	73587	74060	74528	74991	32
15	70166	70669	71168	71662	72152	72637	73119	73595	74067	74535	74999	33
30	70175	70678	71176	71670	72160	72645	73127	73603	74075	74543	75006	34
45	70183	70686	71184	71679	72168	72654	73135	73611	74083	74551	75014	35
9 0	70191	70694	71193	71687	72176	72662	73142	73619	74091	74559	75022	36
15	70200	70703	71201	71695	72185	72670	73150	736[illegible]	74099	74566	75029	37
30	70208	70711	71209	71703	72193	72678	73158	7363[illegible]	74107	74574	75037	38
45	70217	70719	71218	71711	72201	72686	73166	73643	74114	74582	75045	39
10 0	70225	70728	71226	71720	72209	72694	73174	73650	74122	74590	75053	40
15	70233	70736	71234	71728	72217	72702	73182	73658	74130	74597	75060	41
30	70242	70744	71242	71736	72225	72710	73190	73666	74138	74605	75068	42
45	70250	70753	71251	71744	72233	72718	73198	73674	74146	74613	75076	43
11 0	70259	70761	71259	71752	72241	72726	73206	73682	74154	74621	75083	44
15	70267	70769	71267	71761	72249	72734	73214	73690	74161	74628	75091	45
30	70276	70778	71275	71769	72258	72742	73222	73698	74169	74636	75099	46
45	70284	70786	71284	71777	72266	72750	73230	73706	74177	74644	75106	47
12 0	70292	70794	71292	71785	72274	72758	73238	73714	74185	74652	75114	48
15	70301	70803	71300	71793	72282	72766	73246	73721	74193	74658	75122	49
30	70309	70811	71308	71801	72290	72774	73254	73729	74200	74667	75129	50
45	70318	70819	71317	71810	72298	72782	73262	73737	74208	74675	75137	51
13 0	70326	70828	71325	71818	72306	72790	73270	73745	74216	74683	75145	52
15	70334	70836	71333	71826	72314	72798	73278	73753	74224	74690	75152	53
30	70343	70844	71341	71834	72322	72806	73286	73761	74232	74698	75160	54
45	70351	70853	71350	71842	72331	72814	73294	73769	74239	74706	75168	55
14 0	70360	70861	71358	71851	72339	72823	73302	73777	74247	74713	75[illegible]75	56
15	70368	70869	71366	71859	72347	72831	73310	73785	74255	74721	75183	57
30	70376	70878	71374	71867	72355	72839	73318	73792	74263	74729	75191	58
45	70385	70886	71383	71875	72363	72847	73326	73800	74271	74737	75198	59

D. 8.	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
	Parts	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8

LOG. SINE SQUARE

	152°	153°				154°				155°		
	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	
	10h11m	10h12m	10h13m	10h14m	10h15m	10h16m	10h17m	10h18m	10h19m	10h20m	10h21m	s.
′ ″	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	
0 0	75206	75663	76116	76564	77008	77448	77883	78314	78741	79163	79581	0
15	75214	75671	76123	76572	77016	77455	77890	78321	78748	79170	79588	1
30	75221	75678	76131	76579	77023	77462	77898	78328	78755	79177	79595	2
45	75229	75686	76138	76586	77030	77470	77905	78336	78762	79184	79602	3
1 0	75237	75693	76146	76594	77038	77477	77912	78343	78769	79191	79609	4
15	75244	75701	76153	76601	77045	77484	77919	78350	78776	79198	79616	5
30	75252	75708	76161	76609	77052	77492	77926	78357	78783	79205	79622	6
45	75259	75716	76168	76616	77060	77499	77934	78364	78790	79212	79629	7
2 0	75267	75724	76176	76624	77067	77506	77941	78371	78797	79219	79636	8
15	75275	75731	76183	76631	77074	77513	77948	78378	78804	79226	79643	9
30	75282	75739	76191	76638	77082	77521	77955	78386	78811	79233	79650	10
45	75290	75746	76198	76646	77089	77528	77963	78393	78819	79240	79657	11
3 0	75298	75754	76206	76653	77096	77535	77970	78400	78826	79247	79664	12
15	75305	75761	76213	76661	77104	77543	77977	78407	78833	79254	79671	13
30	75313	75769	76221	76668	77111	77550	77984	78414	78840	79261	79678	14
45	75321	75777	76228	76676	77118	77557	77991	78421	78847	79268	79685	15
4 0	75328	75784	76236	76683	77126	77564	77999	78428	78854	79275	79692	16
15	75336	75792	76243	76690	77133	77572	78006	78436	78861	79282	79699	17
30	75343	75799	76251	76698	77141	77579	78013	78443	78868	79289	79705	18
45	75351	75807	76258	76705	77148	77586	78020	78450	78875	79296	79712	19
5 0	75359	75814	76266	76713	77155	77593	78027	78457	78882	79303	79719	20
15	75366	75822	76273	76720	77163	77601	78034	78464	78889	79310	79726	21
30	75374	75830	76281	76727	77170	77608	78042	78471	78896	79317	79733	22
45	75382	75837	76288	76735	77177	77615	78049	78478	78903	79324	79740	23
6 0	75389	75845	76296	76742	77185	77622	78056	78485	78910	79331	79747	24
15	75397	75852	76303	76750	77192	77630	78063	78492	78917	79338	79754	25
30	75405	75860	76311	76757	77199	77637	78070	78500	78924	79345	79761	26
45	75412	75867	76318	76765	77207	77644	78078	78507	78931	79352	79768	27
7 0	75420	75875	76326	76772	77214	77652	78085	78514	78938	79359	79775	28
15	75427	75882	76333	76779	77221	77659	78092	78521	78945	79366	79781	29
30	75435	75890	76341	76787	77229	77666	78099	78528	78952	79373	79788	30
45	75443	75897	76348	76794	77236	77673	78106	78535	78959	79379	79795	31
8 0	75450	75905	76355	76802	77243	77681	78114	78542	78967	79386	79802	32
15	75458	75912	76363	76809	77251	77688	78121	78549	78974	79393	79809	33
30	75465	75920	76370	76816	77258	77695	78128	78556	78981	79400	79816	34
45	75473	75928	76378	76824	77265	77702	78135	78563	78988	79407	79823	35
9 0	75481	75935	76385	76831	77272	77710	78142	78571	78995	79414	79830	36
15	75488	75943	76393	76839	77280	77717	78149	78578	79002	79421	79836	37
30	75496	75950	76400	76846	77287	77724	78157	78585	79009	79428	79843	38
45	75504	75958	76408	76853	77294	77731	78164	78592	79016	79435	79850	39
10 0	75511	75965	76415	76861	77302	77739	78171	78599	79023	79442	79857	40
15	75519	75973	76423	76868	77309	77746	78178	78606	79030	79449	79864	41
30	75526	75980	76430	76875	77316	77753	78185	78613	79037	79456	79871	42
45	75534	75988	76438	76883	77324	77760	78192	78620	79044	79463	79878	43
11 0	75542	75995	76445	76890	77331	77768	78200	78627	79051	79470	79885	44
15	75549	76003	76452	76898	77338	77775	78207	78634	79058	79477	79892	45
30	75557	76011	76460	76905	77346	77782	78214	78643	79065	79484	79898	46
45	75564	76018	76467	76912	77353	77789	78221	78649	79072	79491	79905	47
12 0	75572	76026	76475	76920	77360	77796	78228	78656	79079	79498	79912	48
15	75580	76033	76482	76927	77367	77804	78235	78663	79086	79505	79919	49
30	75587	76041	76490	76934	77375	77811	78243	78670	79093	79512	79926	50
45	75595	76048	76497	76942	77382	77818	78250	78677	79100	79519	79933	51
13 0	75602	76056	76505	76949	77389	77825	78257	78684	79107	79525	79940	52
15	75610	76063	76512	76957	77397	77833	78264	78691	79114	79532	79946	53
30	75618	76071	76520	76964	77404	77840	78271	78698	79121	79539	79953	54
45	75625	76078	76527	76971	77411	77847	78278	78705	79128	79546	79960	55
14 0	75633	76086	76534	76979	77419	77854	78286	78712	79135	79553	79967	56
15	75640	76093	76542	76986	77426	77861	78293	78719	79142	79560	79974	57
30	75648	76101	76549	76993	77433	77869	78300	78727	79149	79567	79981	58
45	75655	76108	76557	77001	77441	77876	78307	78734	79156	79574	79988	59

D 7.	Sec.	1′	2	3′	4′	5	6′	7	8	9′	10	11′	12	13′	14	15′
	Parts	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7

LOG. SINE SQUARE

	155°		156°				157°				158°	
	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	
	10h22m	10h23m	10h24m	10h25m	10h26m	10h27m	10h28m	10h29m	10h30m	10h31m	10h32m	s
′ ″	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	
0 0	79995	80404	80809	81209	81606	81998	82385	82769	83148	83523	83893	0
15	80001	80411	80816	81216	81612	82004	82392	82775	83154	83529	83899	1
30	80008	80417	80822	81223	81619	82011	82398	82782	83160	83535	83905	2
45	80015	80424	80829	81229	81625	82017	82405	82788	83167	83541	83912	3
1 0	80022	80431	80836	81236	81632	82024	82411	82794	83173	83547	83918	4
15	80029	80438	80842	81243	81639	82030	82417	82801	83179	83554	83924	5
30	80036	80444	80849	81249	81645	82037	82424	82807	83186	83560	83930	6
45	80043	80451	80856	81256	81652	82043	82430	82813	83192	83566	83936	7
2 0	80049	80458	80862	81262	81658	82050	82437	82820	83198	83572	83942	8
15	80056	80465	80869	81269	81665	82056	82443	82826	83204	83579	83948	9
30	80063	80472	80876	81276	81671	82063	82450	82832	83211	83585	83954	10
45	80070	80478	80883	81282	81678	82069	82456	82839	83217	83591	83961	11
3 0	80077	80485	80889	81289	81684	82076	82462	82845	83223	83597	83967	12
15	80084	80492	80896	81296	81691	82082	82469	82851	83229	83603	83973	13
30	80090	80499	80903	81302	81698	82089	82475	82857	83236	83610	83979	14
45	80097	80505	80909	81309	81704	82095	82482	82864	83242	83616	83985	15
4 0	80104	80512	80916	81315	81711	82102	82488	82870	83248	83622	83991	16
15	80111	80519	80923	81322	81717	82108	82494	82877	83254	83628	83997	17
30	80118	80526	80929	81329	81724	82114	82501	82883	83261	83634	84003	18
45	80125	80533	80936	81335	81730	82121	82507	82889	83267	83640	84010	19
5 0	80131	80539	80943	81342	81737	82127	82514	82896	83273	83647	84016	20
15	80138	80546	80949	81348	81743	82134	82520	82902	83280	83653	84022	21
30	80145	80553	80956	81355	81750	82140	82526	82908	83286	83659	84028	22
45	80152	80560	80963	81362	81756	82147	82533	82915	83292	83665	84034	23
6 0	80159	80566	80970	81368	81763	82153	82539	82921	83298	83671	84040	24
15	80166	80573	80976	81375	81770	82160	82546	82927	83305	83678	84046	25
30	80172	80580	80983	81382	81776	82166	82552	82934	83311	83684	84052	26
45	80179	80587	80990	81388	81783	82173	82558	82940	83317	83690	84058	27
7 0	80186	80593	80996	81395	81789	82179	82565	82946	83323	83696	84065	28
15	80193	80600	81003	81401	81796	82186	82571	82953	83330	83702	84071	29
30	80200	80607	81010	81408	81802	82192	82578	82959	83336	83708	84077	30
45	80207	80614	81016	81415	81809	82199	82584	82965	83342	83715	84083	31
8 0	80213	80620	81023	81421	81815	82205	82590	82972	83348	83721	84089	32
15	80220	80627	81030	81428	81822	82211	82597	82978	83355	83727	84095	33
30	80227	80634	81036	81435	81828	82218	82603	82984	83361	83733	84101	34
45	80234	80641	81043	81441	81835	82224	82610	82990	83367	83739	84107	35
9 0	80241	80647	81050	81448	81841	82231	82616	82997	83373	83745	84113	36
15	80247	80654	81056	81454	81848	82237	82622	83003	83379	83752	84119	37
30	80254	80661	81063	81461	81854	82244	82629	83009	83386	83758	84126	38
45	80261	80668	81070	81468	81861	82250	82635	83016	83392	83764	84132	39
10 0	80268	80674	81076	81474	81867	82257	82641	83022	83398	83770	84138	40
15	80275	80681	81083	81481	81874	82263	82648	83028	83404	83776	84144	41
30	80282	80688	81090	81487	81881	82270	82654	83035	83411	83782	84150	42
45	80288	80694	81096	81494	81887	82276	82661	83041	83417	83789	84156	43
11 0	80295	80701	81103	81501	81894	82282	82667	83047	83423	83795	84162	44
15	80302	80708	81110	81507	81900	82289	82673	83054	83429	83801	84168	45
30	80309	80715	81116	81514	81907	82295	82680	83060	83436	83807	84174	46
45	80316	80721	81123	81520	81913	82302	82686	83066	83442	83813	84180	47
12 0	80322	80728	81130	81527	81920	82308	82692	83072	83448	83819	84186	48
15	80329	80735	81136	81533	81926	82315	82699	83079	83454	83826	84193	49
30	80336	80742	81143	81540	81933	82321	82705	83085	83460	83832	84199	50
45	80343	80748	81150	81547	81939	82328	82712	83091	83467	83838	84205	51
13 0	80349	80755	81156	81553	81946	82334	82718	83098	83473	83844	84211	52
15	80356	80762	81163	81560	81952	82340	82724	83104	83479	83850	84217	53
30	80363	80768	81169	81566	81959	82347	82731	83110	83485	83856	84223	54
45	80370	80775	81176	81573	81965	82353	82737	83116	83492	83862	84229	55
14 0	80377	80782	81183	81580	81972	82360	82743	83123	83498	83869	84235	56
15	80383	80789	81189	81586	81978	82366	82750	83129	83504	83875	84241	57
30	80390	80795	81196	81593	81985	82373	82756	83135	83510	83881	84247	58
45	80397	80802	81203	81599	81991	82379	82762	83142	83516	83887	84253	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 7.	Parts	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7

LOG. SINE SQUARE

	158°			159°				160°				
	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	
	10h33m	10h34m	10h35m	10h36m	10h37m	10h38m	10h39m	10h40m	10h41m	10h42m	10h43m	s.
′ ″	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	
0 0	84259	84621	84979	85332	85681	86026	86367	86703	87035	87363	87686	0
15	84265	84627	84985	85338	85687	86032	86372	86709	87040	87368	87692	1
30	84271	84633	84991	85344	85693	86038	86378	86714	87046	87373	87697	2
45	84278	84639	84997	85350	85699	86043	86384	86720	87051	87379	87702	3
1 0	84284	84645	85003	85356	85704	86049	86389	86725	87057	87384	87708	4
15	84290	84651	85008	85361	85710	86055	86395	86731	87062	87390	87713	5
30	84296	84657	85014	85367	85716	86060	86400	86736	87068	87395	87718	6
45	84302	84663	85020	85373	85722	86066	86406	86742	87073	87401	87724	7
2 0	84308	84669	85026	85379	85728	86072	86412	86747	87079	87406	87729	8
15	84314	84675	85032	85385	85733	86077	86417	86753	87084	87411	87734	9
30	84320	84681	85038	85391	85739	86083	86423	86758	87090	87417	87740	10
45	84326	84687	85044	85397	85745	86089	86429	86764	87095	87422	87745	11
3 0	84332	84693	85050	85402	85751	86095	86434	86770	87101	87428	87750	12
15	84338	84699	85056	85408	85756	86100	86440	86775	87106	87433	87756	13
30	84344	84705	85062	85414	85762	86106	86445	86781	87112	87439	87761	14
45	84350	84711	85068	85420	85768	86112	86451	86786	87117	87444	87766	15
4 0	84356	84717	85074	85426	85774	86117	86457	86792	87123	87449	87772	16
15	84362	84723	85080	85432	85779	86123	86462	86797	87128	87455	87777	17
30	84368	84729	85085	85437	85785	86129	86468	86803	87134	87460	87782	18
45	84374	84735	85091	85443	85791	86134	86474	86808	87139	87466	87788	19
5 0	84380	84741	85097	85449	85797	86140	86479	86814	87145	87471	87793	20
15	84387	84747	85103	85455	85802	86146	86485	86820	87150	87476	87798	21
30	84393	84753	85109	85461	85808	86151	86490	86825	87156	87482	87804	22
45	84399	84759	85115	85467	85814	86157	86496	86831	87161	87487	87809	23
6 0	84405	84765	85121	85472	85820	86163	86502	86836	87167	87493	87814	24
15	84411	84771	85127	85478	85826	86168	86507	86842	87172	87498	87820	25
30	84417	84777	85133	85484	85831	86174	86513	86847	87177	87503	87825	26
45	84423	84783	85138	85490	85837	86180	86519	86853	87183	87509	87830	27
7 0	84429	84789	85144	85496	85843	86186	86524	86858	87188	87514	87836	28
15	84435	84795	85150	85502	85848	86191	86530	86864	87194	87520	87841	29
30	84441	84801	85156	85507	85854	86197	86535	86869	87199	87525	87846	30
45	84447	84807	85162	85513	85860	86203	86541	86875	87205	87530	87852	31
8 0	84453	84813	85168	85519	85866	86208	86546	86881	87210	87536	87857	32
15	84459	84818	85174	85525	85872	86214	86552	86886	87216	87541	87862	33
30	84465	84824	85180	85531	85877	86220	86558	86892	87221	87547	87867	34
45	84471	84830	85186	85536	85883	86225	86563	86897	87227	87552	87873	35
9 0	84477	84836	85191	85542	85889	86231	86569	86903	87232	87557	87878	36
15	84483	84842	85197	85548	85894	86237	86574	86908	87237	87563	87883	37
30	84489	84848	85203	85554	85900	86242	86580	86914	87243	87568	87889	38
45	84495	84854	85209	85560	85906	86248	86586	86919	87248	87573	87894	39
10 0	84501	84860	85215	85565	85912	86254	86591	86925	87254	87579	87899	40
15	84507	84866	85221	85571	85917	86259	86597	86930	87259	87584	87905	41
30	84513	84872	85227	85577	85923	86265	86602	86936	87265	87590	87910	42
45	84519	84878	85233	85583	85929	86271	86608	86941	87270	87595	87915	43
11 0	84525	84884	85238	85589	85935	86276	86614	86947	87276	87600	87921	44
15	84531	84890	85244	85594	85940	86282	86619	86952	87281	87606	87926	45
30	84537	84896	85250	85600	85946	86288	86625	86958	87286	87611	87931	46
45	84543	84902	85256	85606	85952	86293	86630	86963	87292	87616	87937	47
12 0	84549	84908	85262	85612	85958	86299	86636	86969	87297	87622	87942	48
15	84555	84914	85268	85618	85963	86305	86642	86974	87303	87627	87947	49
30	84561	84920	85274	85623	85969	86310	86647	86980	87308	87633	87952	50
45	84567	84926	85280	85629	85975	86316	86653	86985	87314	87638	87958	51
13 0	84573	84931	85285	85635	85980	86321	86658	86991	87319	87643	87963	52
15	84579	84937	85291	85641	85986	86327	86664	86996	87325	87649	87968	53
30	84585	84943	85297	85647	85992	86333	86669	87002	87330	87654	87974	54
45	84591	84949	85303	85652	85998	86338	86675	87007	87335	87659	87979	55
14 0	84597	84955	85309	85658	86003	86344	86681	87013	87341	87665	87984	56
15	84603	84961	85315	85664	86009	86350	86686	87018	87346	87670	87990	57
30	84609	84967	85321	85670	86015	86355	86692	87024	87352	87675	87995	58
45	84615	84973	85326	85676	86020	86361	86697	87029	87357	87681	88000	59

D 6.	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
	Parts	0	1	1	2	2	2	3	3	4	4	4	5	5	6	6

LOG. SINE SQUARE

	161°				162°				163°			
	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	
′ ″	10h44m	10h45m	10h46m	10h47m	10h48m	10h49m	10h50m	10h51m	10h52m	10h53m	10h54m	s.
	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	
0 0	88005	88320	88631	88938	89240	89538	89832	90121	90407	90688	90964	0
15	88011	88326	88636	88943	89245	89543	89836	90126	90411	90692	90969	1
30	88016	88331	88641	88948	89250	89548	89841	90131	90416	90697	90974	2
45	88021	88336	88647	88953	89255	89553	89846	90136	90421	90702	90978	3
1 0	88026	88341	88652	88958	89260	89558	89851	90140	90425	90706	90983	4
15	88032	88346	88657	88963	89265	89562	89856	90145	90430	90711	90987	5
30	88037	88352	88662	88968	89270	89567	89861	90150	90435	90715	90992	6
45	88042	88357	88667	88973	89275	89572	89866	90155	90439	90720	90996	7
2 0	88048	88362	88672	88978	89280	89577	89870	90159	90444	90725	91001	8
15	88053	88367	88677	88983	89285	89582	89875	90164	90449	90729	91006	9
30	88058	88372	88682	88988	89290	89587	89880	90169	90454	90734	91010	10
45	88063	88378	88688	88993	89295	89592	89885	90174	90458	90739	91015	11
3 0	88069	88383	88693	88998	89300	89597	89890	90179	90463	90743	91019	12
15	88074	88388	88698	89003	89305	89602	89895	90183	90468	90748	91024	13
30	88079	88393	88703	89008	89310	89607	89899	90188	90472	90753	91028	14
45	88085	88398	88708	89014	89315	89612	89904	90193	90477	90757	91033	15
4 0	88090	88404	88713	89019	89320	89617	89909	90198	90482	90762	91038	16
15	88095	88409	88718	89024	89325	89621	89914	90202	90487	90766	91042	17
30	88100	88414	88723	89029	89330	89626	89919	90207	90491	90771	91047	18
45	88106	88419	88729	89034	89335	89631	89924	90212	90496	90776	91051	19
5 0	88111	88424	88734	89039	89340	89636	89929	90217	90501	90780	91056	20
15	88116	88430	88739	89044	89345	89641	89933	90221	90505	90785	91060	21
30	88121	88435	88744	89049	89350	89646	89938	90226	90510	90790	91065	22
45	88127	88440	88749	89054	89355	89651	89943	90231	90515	90794	91069	23
6 0	88132	88445	88754	89059	89360	89656	89948	90236	90519	90799	91074	24
15	88137	88450	88759	89064	89365	89661	89953	90241	90524	90803	91079	25
30	88142	88456	88764	89069	89370	89666	89958	90245	90529	90808	91083	26
45	88148	88461	88769	89074	89375	89671	89962	90250	90533	90813	91088	27
7 0	88153	88466	88775	89079	89379	89675	89967	90255	90538	90817	91092	28
15	88158	88471	88780	89084	89384	89680	89972	90260	90543	90822	91097	29
30	88163	88476	88785	89089	89389	89685	89977	90264	90548	90827	91101	30
45	88169	88481	88790	89094	89394	89690	89982	90269	90552	90831	91106	31
8 0	88174	88487	88795	89099	89399	89695	89987	90274	90557	90836	91110	32
15	88179	88492	88800	89104	89404	89700	89991	90279	90562	90840	91115	33
30	88184	88497	88805	89109	89409	89705	89996	90283	90566	90845	91119	34
45	88190	88502	88810	89114	89414	89710	90001	90288	90571	90850	91124	35
9 0	88195	88507	88815	89119	89419	89715	90006	90293	90576	90854	91129	36
15	88200	88513	88821	89124	89424	89719	90011	90298	90580	90859	91133	37
30	88205	88518	88826	89129	89429	89724	90015	90302	90585	90863	91138	38
45	88211	88523	88831	89134	89434	89729	90020	90307	90590	90868	91142	39
10 0	88216	88528	88836	89140	89439	89734	90025	90312	90594	90873	91147	40
15	88221	88533	88841	89145	89444	89739	90030	90317	90599	90877	91151	41
30	88226	88538	88846	89150	89449	89744	90035	90321	90604	90882	91156	42
45	88232	88544	88851	89155	89454	89749	90040	90326	90608	90886	91160	43
11 0	88237	88549	88856	89160	89459	89754	90044	90331	90613	90891	91165	44
15	88242	88554	88861	89165	89464	89759	90049	90336	90618	90896	91169	45
30	88247	88559	88866	89170	89469	89763	90054	90340	90622	90900	91174	46
45	88252	88564	88871	89175	89474	89768	90059	90345	90627	90905	91178	47
12 0	88258	88569	88877	89180	89479	89773	90064	90350	90632	90909	91183	48
15	88263	88575	88882	89185	89484	89778	90068	90354	90636	90914	91187	49
30	88268	88580	88887	89190	89488	89783	90073	90359	90641	90919	91192	50
45	88273	88585	88892	89195	89493	89788	90078	90364	90646	90923	91196	51
13 0	88279	88590	88897	80200	89498	89793	90083	90369	90650	90928	91201	52
15	88284	88595	88902	89205	89503	89798	90088	90373	90655	90932	91205	53
30	88289	88600	88907	89210	89508	89802	90092	90378	90660	90937	91210	54
45	88294	88605	88912	89215	89513	89807	90097	90383	90664	90942	91214	55
14 0	88300	88611	88917	89220	89518	89812	90102	90388	90669	90946	91219	56
15	88305	88616	88922	89225	89523	89817	90107	90392	90674	90951	91224	57
30	88310	88621	88927	89230	89528	89822	90112	90397	90678	90955	91228	58
45	88315	88626	88933	89235	89533	89827	90116	90402	90683	90960	91233	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D. 5.	Parts	0	1	1	1	2	2	2	3	3	3	4	4	4	5	5

LOG. SINE SQUARE

	163°	164°				165°				166°		
	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	
	10h55m	10h56m	10h57m	10h58m	10h59m	11h 0m	11h 1m	11h 2m	11h 3m	11h 4m	11h 5m	s.
′ ″	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	
0 0	91237	91506	91770	92030	92286	92537	92785	93028	93267	93501	93732	0
15	91242	91510	91774	92034	92290	92541	92789	93032	93271	93505	93736	1
30	91246	91514	91779	92038	92294	92545	92793	93036	93274	93509	93740	2
45	91251	91519	91783	92043	92298	92550	92797	93040	93278	93513	93743	3
1 0	91255	91523	91787	92047	92302	92554	92801	93044	93282	93517	93747	4
15	91260	91528	91792	92051	92307	92558	92805	93048	93286	93521	93751	5
30	91264	91532	91796	92056	92311	92562	92809	93052	93290	93525	93755	6
45	91269	91537	91800	92060	92315	92566	92813	93056	93294	93528	93759	7
2 0	91273	91541	91805	92064	92319	92570	92817	93060	93298	93532	93762	8
15	91278	91545	91809	92068	92324	92575	92821	93064	93302	93536	93766	9
30	91282	91550	91813	92073	92328	92579	92825	93068	93306	93540	93770	10
45	91287	91554	91818	92077	92332	92583	92829	93072	93310	93544	93774	11
3 0	91291	91559	91822	92081	92336	92587	92833	93076	93314	93548	93778	12
15	91296	91563	91827	92086	92340	92591	92837	93080	93318	93552	93781	13
30	91300	91568	91831	92090	92345	92595	92842	93084	93322	93556	93785	14
45	91305	91572	91835	92094	92349	92599	92846	93088	93326	93559	93789	15
4 0	91309	91576	91840	92098	92353	92604	92850	93092	93330	93563	93793	16
15	91314	91581	91844	92103	92357	92608	92854	93096	93334	93567	93797	17
30	91318	91585	91848	92107	92361	92612	92858	93100	93338	93571	93800	18
45	91323	91590	91853	92111	92366	92616	92862	93104	93341	93575	93804	19
5 0	91327	91594	91857	92116	92370	92620	92866	93108	93345	93579	93808	20
15	91332	91598	91861	92120	92374	92624	92870	93112	93349	93583	93812	21
30	91336	91603	91866	92124	92378	92628	92874	93116	93353	93586	93815	22
45	91341	91607	91870	92128	92382	92632	92878	93120	93357	93590	93819	23
6 0	91345	91612	91874	92133	92387	92637	92882	93124	93361	93594	93823	24
15	91350	91616	91879	92137	92391	92641	92886	93128	93365	93598	93827	25
30	91354	91621	91883	92141	92395	92645	92890	93132	93369	93602	93831	26
45	91359	91625	91887	92145	92399	92649	92894	93136	93373	93606	93834	27
7 0	91363	91629	91892	92150	92403	92653	92898	93140	93377	93609	93838	28
15	91367	91634	91896	92154	92408	92657	92903	93144	93381	93613	93842	29
30	91372	91638	91900	92158	92412	92661	92907	93148	93385	93617	93846	30
45	91376	91643	91905	92163	92416	92665	92911	93152	93389	93621	93849	31
8 0	91381	91647	91909	92167	92420	92670	92915	93156	93392	93625	93853	32
15	91385	91651	91913	92171	92424	92674	92919	93160	93396	93629	93857	33
30	91390	91656	91918	92175	92429	92678	92923	93164	93400	93633	93861	34
45	91394	91660	91922	92180	92433	92682	92927	93168	93404	93636	93865	35
9 0	91399	91665	91926	92184	92437	92686	92931	93172	93408	93640	93868	36
15	91403	91669	91930	92188	92441	92690	92935	93176	93412	93644	93872	37
30	91408	91673	91935	92192	92445	92694	92939	93179	93416	93648	93876	38
45	91412	91678	91939	92197	92449	92698	92943	93183	93420	93652	93880	39
10 0	91417	91682	91944	92201	92454	92703	92947	93187	93424	93656	93883	40
15	91421	91687	91948	92205	92458	92707	92951	93191	93427	93659	93887	41
30	91425	91691	91952	92209	92462	92711	92955	93195	93431	93663	93891	42
45	91430	91695	91956	92214	92466	92715	92959	93199	93435	93667	93895	43
11 0	91434	91700	91961	92218	92470	92719	92963	93203	93439	93671	93898	44
15	91439	91704	91965	92222	92475	92723	92967	93207	93443	93675	93902	45
30	91443	91709	91969	92226	92479	92727	92971	93211	93447	93679	93906	46
45	91448	91713	91974	92230	92483	92731	92975	93215	93451	93682	93910	47
12 0	91452	91717	91978	92235	92487	92735	92979	93219	93455	93686	93913	48
15	91457	91722	91982	92239	92491	92739	92983	93223	93459	93690	93917	49
30	91461	91726	91987	92243	92495	92744	92987	93227	93463	93694	93921	50
45	91466	91730	91991	92247	92500	92748	92991	93231	93466	93698	93925	51
13 0	91470	91735	91995	92252	92504	92752	92995	93235	93470	93702	93928	52
15	91474	91739	92000	92256	92508	92756	92999	93239	93474	93705	93932	53
30	91479	91743	92004	92260	92512	92760	93003	93243	93478	93709	93936	54
45	91483	91748	92008	92264	92516	92764	93008	93247	93482	93713	93940	55
14 0	91488	91752	92013	92269	92520	92768	93012	93251	93486	93717	93943	56
15	91492	91757	92017	92273	92525	92772	93016	93255	93490	93721	93947	57
30	91497	91761	92021	92277	92529	92776	93020	93259	93494	93724	93951	58
45	91501	91765	92025	92281	92533	92780	93024	93263	93498	93728	93955	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
D 1	Parts	0	1	1	1	1	2	2	2	2	3	3	3	3	3	4

LOG. SINE SQUARE

	166°		167°				168°				169°	
	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	
	11h 6m	11h 7m	11h 8m	11h 9m	11h 10m	11h 11m	11h 12m	11h 13m	11h 14m	11h 15m	11h 16m	s.
′ ″	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	
0 0	93958	94181	94399	94612	94822	95027	95229	95426	95619	95807	95992	0
15	93962	94184	94402	94616	94825	95031	95232	95429	95622	95811	95995	1
30	93966	94188	94406	94619	94829	95034	95235	95432	95625	95814	95998	2
45	93970	94192	94409	94623	94832	95038	95239	95436	95628	95817	96001	3
1 0	93973	94195	94413	94626	94836	95041	95242	95439	95631	95820	96004	4
15	93977	94199	94417	94630	94839	95044	95245	95442	95635	95823	96007	5
30	93981	94202	94420	94633	94843	95048	95248	95445	95638	95826	96010	6
45	93984	94206	94424	94637	94846	95051	95252	95448	95641	95829	96013	7
2 0	93988	94210	94427	94641	94850	95054	95255	95452	95644	95832	96016	8
15	93992	94213	94431	94644	94853	95058	95259	95455	95647	95835	96019	9
30	93996	94217	94434	94648	94856	95061	95262	95458	95650	95838	96022	10
45	93999	94221	94438	94651	94860	95065	95265	95461	95654	95842	96025	11
3 0	94003	94224	94442	94655	94863	95068	95268	95465	95657	95845	96028	12
15	94007	94228	94445	94658	94867	95071	95272	95468	95660	95848	96031	13
30	94011	94232	94449	94662	94870	95075	95275	95471	95663	95851	96034	14
45	94014	94235	94452	94665	94874	95078	95278	95474	95666	95854	96037	15
4 0	94018	94239	94456	94669	94877	95081	95282	95478	95669	95857	96040	16
15	94022	94243	94460	94672	94881	95085	95285	95481	95673	95860	96043	17
30	94025	94246	94463	94676	94884	95088	95288	95484	95676	95863	96047	18
45	94029	94250	94467	94679	94887	95092	95292	95487	95679	95866	96050	19
5 0	94033	94254	94470	94683	94891	95095	95295	95491	95682	95869	96053	20
15	94037	94257	94474	94686	94894	95098	95298	95494	95685	95872	96056	21
30	94040	94261	94477	94690	94898	95102	95301	95497	95688	95876	96059	22
45	94044	94265	94481	94693	94901	95105	95305	95500	95692	95879	96062	23
6 0	94048	94268	94485	94697	94905	95108	95308	95503	95695	95882	96065	24
15	94051	94272	94488	94700	94908	95112	95311	95507	95698	95885	96068	25
30	94055	94275	94492	94704	94911	95115	95315	95510	95701	95888	96071	26
45	94059	94279	94495	94707	94915	95118	95318	95513	95704	95891	96074	27
7 0	94063	94283	94499	94711	94918	95122	95321	95516	95707	95894	96077	28
15	94066	94286	94502	94714	94922	95125	95324	95520	95710	95897	96080	29
30	94070	94290	94506	94718	94925	95129	95328	95523	95714	95905	96083	30
45	94074	94294	94510	94721	94929	95132	95331	95526	95717	95903	96086	31
8 0	94077	94297	94513	94725	94932	95135	95334	95529	95720	95906	96089	32
15	94081	94301	94517	94728	94935	95139	95338	95532	95723	95909	96092	33
30	94085	94305	94520	94732	94939	95142	95341	95536	95726	95912	96095	34
45	94088	94308	94524	94735	94942	95145	95344	95539	95729	95916	96098	35
9 0	94092	94312	94527	94739	94946	95149	95347	95542	95732	95919	96101	36
15	94096	94315	94531	94742	94949	95152	95351	95545	95736	95922	96104	37
30	94100	94319	94535	94746	94953	95155	95354	95548	95739	95925	96107	38
45	94103	94323	94538	94749	94956	95159	95357	95552	95742	95928	96110	39
10 0	94107	94326	94542	94752	94959	95162	95361	95555	95745	95931	96113	40
15	94111	94330	94545	94756	94963	95165	95364	95558	95748	95934	96116	41
30	94114	94334	94549	94759	94966	95169	95367	95561	95751	95937	96119	42
45	94118	94337	94552	94763	94970	95172	95370	95564	95754	95940	96122	43
11 0	94122	94341	94556	94766	94973	95175	95374	95568	95757	95943	96125	44
15	94125	94344	94559	94770	94976	95179	95377	95571	95761	95946	96128	45
30	94129	94348	94563	94773	94980	95182	95380	95574	95764	95949	96131	46
45	94133	94352	94566	94777	94983	95185	95383	95577	95767	95952	96134	47
12 0	94136	94355	94570	94780	94987	95189	95387	95580	95770	95955	96137	48
15	94140	94359	94573	94784	94991	95192	95390	95584	95773	95958	96140	49
30	94144	94362	94577	94787	94993	95195	95393	95587	95776	95961	96143	50
45	94147	94366	94581	94791	94997	95199	95396	95590	95779	95965	96146	51
13 0	94151	94370	94584	94794	95000	95202	95400	95593	95782	95968	96149	52
15	94155	94373	94588	94798	95004	95205	95403	95596	95786	95971	96152	53
30	94158	94377	94591	94801	95007	95209	95406	95600	95789	95974	96154	54
45	94162	94381	94595	94805	95010	95212	95410	95603	95792	95977	96157	55
14 0	94166	94384	94598	94808	95014	95215	95413	95606	95795	95980	96160	56
15	94170	94388	94602	94812	95017	95219	95416	95609	95798	95983	96163	57
30	94173	94391	94605	94815	95021	95222	95419	95612	95801	95986	96166	58
45	94177	94395	94609	94819	95024	95225	95423	95615	95805	95989	96169	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10	11″	12″	13	14	15″
D. 3	Parts	0	0	1	1	1	1	1	2	2	2	2	2	3	3	3

LOG. SINE SQUARE

	169°			170°				171°				
	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	
	11h17m	11h18m	11h19m	11h20m	11h21m	11h22m	11h23m	11h24m	11h25m	11h26m	11h27m	s.
′ ″	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	
0 0	96172	96349	96521	96688	96852	97012	97167	97318	97465	97608	97747	0
15	96175	96351	96523	96691	96855	97014	97170	97321	97468	97611	97749	1
30	96178	96354	96526	96694	96858	97017	97172	97323	97470	97613	97752	2
45	96181	96357	96529	96697	96860	97020	97175	97326	97473	97615	97754	3
1 0	96184	96360	96532	96699	96863	97022	97177	97328	97475	97618	97756	4
15	96187	96363	96535	96702	96866	97025	97180	97331	97477	97620	97758	5
30	96190	96366	96538	96705	96868	97027	97182	97333	97480	97622	97761	6
45	96193	96369	96540	96708	96871	97030	97185	97336	97482	97625	97763	7
2 0	96196	96372	96543	96711	96874	97033	97187	97338	97485	97627	97765	8
15	96199	96375	96546	96713	96876	97035	97190	97341	97487	97629	97767	9
30	96202	96377	96549	96716	96879	97038	97193	97343	97489	97632	97770	10
45	96205	96380	96552	96719	96882	97040	97195	97346	97492	97634	97772	11
3 0	96208	96383	96554	96722	96884	97043	97198	97348	97494	97636	97774	12
15	96211	96386	96557	96724	96887	97046	97200	97351	97497	97639	97776	13
30	96214	96389	96560	96727	96890	97048	97203	97353	97499	97641	97779	14
45	96217	96392	96563	96730	96892	97051	97205	97355	97501	97643	97781	15
4 0	96220	96395	96566	96733	96895	97054	97208	97358	97504	97646	97783	16
15	96223	96398	96569	96735	96898	97056	97210	97360	97506	97648	97786	17
30	96226	96401	96571	96738	96900	97059	97213	97363	97509	97650	97788	18
45	96229	96403	96574	96741	96903	97061	97215	97365	97511	97653	97790	19
5 0	96232	96406	96577	96743	96906	97064	97218	97368	97513	97655	97792	20
15	96234	96409	96580	96746	96908	97067	97220	97370	97516	97657	97795	21
30	96237	96412	96583	96749	96911	97069	97223	97373	97518	97660	97797	22
45	96240	96415	96585	96752	96914	97072	97226	97375	97521	97662	97799	23
6 0	96243	96418	96588	96754	96916	97074	97228	97378	97523	97664	97801	24
15	96246	96421	96591	96757	96919	97077	97231	97380	97525	97667	97804	25
30	96249	96424	96593	96760	96922	97079	97233	97383	97528	97669	97806	26
45	96252	96426	96597	96763	96924	97082	97236	97385	97530	97671	97808	27
7 0	96255	96429	96599	96765	96927	97085	97238	97387	97532	97673	97810	28
15	96258	96432	96602	96768	96930	97087	97241	97390	97535	97676	97813	29
30	96261	96435	96605	96771	96932	97090	97243	97392	97537	97678	97815	30
45	96264	96438	96608	96774	96935	97092	97246	97395	97540	97680	97817	31
8 0	96267	96441	96611	96776	96938	97095	97248	97397	97542	97683	97819	32
15	96270	96444	96613	96779	96940	97098	97251	97400	97544	97685	97822	33
30	96273	96447	96616	96782	96943	97100	97253	97402	97547	97687	97824	34
45	96276	96449	96619	96784	96946	97103	97256	97405	97549	97690	97826	35
9 0	96279	96452	96622	96787	96948	97105	97258	97407	97552	97692	97828	36
15	96281	96455	96625	96790	96951	97108	97261	97409	97554	97694	97830	37
30	96284	96458	96627	96792	96954	97111	97263	97412	97556	97697	97833	38
45	96287	96461	96630	96795	96956	97113	97266	97414	97559	97699	97835	39
10 0	96290	96464	96633	96798	96959	97116	97268	97417	97561	97701	97837	40
15	96293	96467	96636	96801	96962	97118	97271	97419	97563	97703	97839	41
30	96296	96469	96638	96803	96964	97121	97273	97422	97566	97706	97842	42
45	96299	96472	96641	96806	96967	97124	97276	97424	97568	97708	97844	43
11 0	96302	96475	96644	96809	96970	97126	97278	97426	97570	97710	97846	44
15	96305	96478	96647	96812	96972	97129	97281	97429	97573	97713	97848	45
30	96308	96481	96650	96814	96975	97131	97283	97431	97575	97715	97850	46
45	96311	96484	96652	96817	96978	97134	97286	97434	97578	97717	97853	47
12 0	96314	96487	96655	96820	96980	97136	97288	97436	97580	97719	97855	48
15	96317	96489	96658	96822	96983	97139	97291	97439	97582	97722	97857	49
30	96319	96492	96661	96825	96985	97141	97293	97441	97585	97724	97859	50
45	96322	96495	96664	96828	96988	97144	97296	97444	97587	97726	97862	51
13 0	96325	96498	96666	96831	96991	97147	97298	97446	97589	97729	97864	52
15	96328	96501	96669	96833	96993	97149	97301	97448	97592	97731	97866	53
30	96331	96504	96672	96836	96996	97152	97303	97451	97594	97733	97868	54
45	96334	96506	96675	96839	96999	97154	97306	97453	97596	97736	97870	55
14 0	96337	96509	96677	96841	97001	97157	97308	97456	97599	97738	97873	56
15	96340	96512	96680	96844	97004	97159	97311	97458	97601	97740	97875	57
30	96343	96515	96683	96847	97006	97162	97313	97460	97603	97742	97877	58
45	96346	96518	96686	96849	97009	97165	97316	97463	97606	97745	97879	59

D. 3.	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
	Parts	0	0	1	1	1	1	1	2	2	2	2	2	3	3	3

LOG. SINE SQUARE

	172°				173°				174°			
	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	
	11h28m	11h29m	11h30m	11h31m	11h32m	11h33m	11h34m	11h35m	11h36m	11h37m	11h38m	s.
′ ″	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	
0 0	97882	98013	98138	98260	98378	98492	98602	98707	98809	98906	98999	0
15	97884	98014	98140	98262	98380	98494	98604	98709	98810	98908	99001	1
30	97886	98016	98142	98264	98382	98496	98605	98711	98812	98909	99002	2
45	97888	98018	98144	98266	98384	98498	98607	98713	98814	98911	99004	3
1 0	97890	98020	98146	98268	98386	98500	98609	98714	98815	98912	99005	4
15	97893	98023	98149	98270	98388	98501	98611	98716	98817	98914	99007	5
30	97895	98025	98151	98272	98390	98503	98613	98718	98819	98916	99008	6
45	97897	98027	98153	98274	98392	98505	98614	98719	98820	98917	99010	7
2 0	97899	98029	98155	98276	98394	98507	98616	98721	98822	98919	99011	8
15	97901	98031	98157	98278	98396	98509	98618	98723	98824	98920	99013	9
30	97904	98033	98159	98280	98398	98511	98620	98725	98825	98922	99014	10
45	97906	98036	98161	98282	98400	98513	98621	98726	98827	98923	99016	11
3 0	97908	98038	98163	98284	98402	98514	98623	98728	98829	98925	99017	12
15	97910	98040	98165	98286	98403	98516	98625	98730	98830	98926	99019	13
30	97912	98042	98167	98288	98405	98518	98627	98731	98832	98928	99020	14
45	97915	98044	98169	98290	98407	98520	98629	98733	98834	98930	99022	15
4 0	97917	98046	98171	98292	98409	98522	98630	98735	98835	98931	99023	16
15	97919	98048	98173	98294	98411	98524	98632	98736	98837	98933	99025	17
30	97921	98050	98175	98296	98413	98526	98634	98738	98838	98934	99027	18
45	97923	98052	98177	98298	98415	98527	98636	98740	98840	98936	99028	19
5 0	97926	98054	98179	98300	98417	98529	98637	98742	98842	98938	99029	20
15	97928	98057	98181	98302	98419	98531	98639	98743	98843	98939	99031	21
30	97930	98059	98183	98304	98421	98533	98641	98745	98845	98941	99032	22
45	97932	98061	98186	98306	98422	98535	98643	98747	98847	98942	99034	23
6 0	97934	98063	98188	98308	98424	98537	98644	98749	98848	98944	99035	24
15	97936	98065	98190	98310	98426	98539	98646	98750	98850	98945	99037	25
30	97939	98067	98192	98312	98428	98540	98648	98752	98851	98947	99038	26
45	97941	98069	98194	98314	98430	98542	98650	98753	98853	98948	99040	27
7 0	97943	98071	98196	98316	98432	98544	98652	98755	98855	98950	99041	28
15	97945	98074	98198	98318	98434	98546	98653	98757	98856	98951	99043	29
30	97947	98076	98200	98320	98436	98548	98655	98759	98858	98953	99044	30
45	97949	98078	98202	98322	98438	98549	98658	98760	98860	98955	99046	31
8 0	97952	98080	98204	98324	98440	98551	98659	98762	98861	98956	99047	32
15	97954	98082	98206	98326	98442	98553	98660	98764	98863	98958	99048	33
30	97956	98084	98208	98328	98443	98555	98662	98765	98864	98959	99050	34
45	97958	98086	98210	98330	98445	98557	98664	98767	98866	98961	99052	35
9 0	97960	98088	98212	98332	98447	98558	98666	98769	98868	98962	99053	36
15	97962	98090	98214	98334	98449	98560	98667	98770	98870	98964	99054	37
30	97965	98092	98216	98336	98451	98562	98669	98772	98871	98965	99056	38
45	97967	98094	98218	98338	98453	98564	98671	98774	98872	98967	99057	39
10 0	97969	98097	98220	98340	98455	98566	98673	98775	98874	98969	99059	40
15	97971	98099	98222	98342	98456	98568	98674	98777	98876	98970	99060	41
30	97973	98101	98224	98343	98458	98569	98676	98779	98877	98972	99062	42
45	97975	98103	98226	98345	98460	98571	98678	98781	98879	98973	99063	43
11 0	97977	98105	98228	98347	98462	98573	98680	98782	98881	98975	99065	44
15	97980	98108	98230	98349	98464	98575	98681	98784	98882	98976	99066	45
30	97982	98109	98232	98351	98466	98577	98683	98786	98884	98978	99068	46
45	97984	98111	98234	98353	98468	98579	98685	98787	98885	98979	99069	47
12 0	97986	98113	98236	98355	98470	98580	98687	98789	98887	98981	99071	48
15	97988	98115	98238	98357	98472	98582	98688	98791	98888	98982	99072	49
30	97990	98117	98240	98359	98473	98584	98690	98792	98890	98984	99074	50
45	97993	98120	98242	98361	98475	98586	98692	98794	98892	98985	99075	51
13 0	97995	98122	98244	98363	98477	98588	98694	98796	98893	98987	99076	52
15	97997	98124	98246	98365	98479	98589	98695	98797	98895	98989	99078	53
30	97999	98126	98248	98367	98481	98591	98697	98799	98896	98990	99079	54
45	98001	98128	98250	98369	98483	98593	98699	98800	98898	98992	99081	55
14 0	98003	98130	98252	98371	98485	98595	98701	98802	98900	98993	99082	56
15	98006	98132	98254	98373	98487	98596	98702	98804	98901	98995	99084	57
30	98008	98134	98256	98375	98488	98598	98704	98805	98903	98996	99085	58
45	98010	98136	98258	98376	98490	98600	98706	98807	98904	98998	99087	59

	Sec.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″
1.2.	Parts	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2

LOG. SINE SQUARE

	174°	175°				176°				177°		
	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	
	11h39m	11h40m	11h41m	11h42m	11h43m	11h44m	11h45m	11h46m	11h47m	11h48m	11h49m	s.
′ ″	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	
0 0	99088	99173	99254	99330	99402	99471	99535	99595	99651	99702	99750	0
15	99089	99174	99255	99331	99404	99472	99536	99596	99651	99703	99751	1
30	99091	99176	99256	99333	99405	99473	99537	99597	99652	99704	99751	2
45	99092	99177	99257	99334	99406	99474	99538	99598	99653	99705	99752	3
1 0	99094	99178	99259	99335	99407	99475	99539	99599	99654	99706	99753	4
15	99095	99180	99260	99336	99408	99476	99540	99600	99655	99706	99754	5
30	99097	99181	99261	99337	99409	99477	99541	99600	99656	99707	99754	6
45	99098	99183	99263	99339	99411	99478	99542	99601	99657	99708	99755	7
2 0	99100	99184	99264	99340	99412	99479	99543	99602	99658	99709	99756	8
15	99101	99185	99265	99341	99413	99481	99544	99603	99659	99710	99757	9
30	99103	99187	99267	99342	99414	99482	99545	99604	99659	99711	99757	10
45	99104	99188	99268	99344	99415	99483	99546	99605	99660	99711	99758	11
3 0	99105	99189	99269	99345	99416	99484	99547	99606	99661	99712	99759	12
15	99107	99191	99270	99346	99418	99485	99548	99607	99662	99713	99760	13
30	99108	99192	99272	99347	99419	99486	99549	99608	99664	99714	99760	14
45	99110	99193	99273	99349	99420	99487	99550	99609	99664	99715	99761	15
4 0	99111	99195	99274	99350	99421	99488	99551	99610	99665	99715	99762	16
15	99113	99196	99276	99351	99422	99489	99552	99611	99666	99716	99763	17
30	99114	99197	99277	99352	99423	99490	99553	99612	99666	99717	99763	18
45	99115	99199	99279	99353	99424	99491	99554	99613	99667	99718	99764	19
5 0	99117	99200	99280	99355	99426	99492	99555	99614	99668	99719	99765	20
15	99118	99202	99281	99356	99427	99494	99556	99615	99669	99719	99765	21
30	99120	99203	99282	99357	99428	99495	99557	99616	99670	99720	99766	22
45	99121	99204	99283	99358	99429	99496	99558	99617	99671	99721	99767	23
6 0	99123	99206	99285	99360	99430	99497	99559	99618	99672	99722	99768	24
15	99124	99207	99286	99361	99431	99498	99560	99618	99673	99723	99768	25
30	99125	99208	99287	99362	99433	99499	99561	99619	99673	99723	99769	26
45	99127	99210	99288	99363	99434	99500	99562	99620	99674	99724	99770	27
7 0	99128	99211	99290	99364	99435	99501	99563	99621	99675	99725	99771	28
15	99130	99212	99291	99366	99436	99502	99564	99622	99676	99726	99771	29
30	99131	99214	99292	99367	99437	99503	99565	99623	99677	99727	99772	30
45	99132	99215	99294	99368	99438	99504	99566	99624	99678	99727	99773	31
8 0	99134	99216	99295	99369	99439	99505	99567	99625	99679	99728	99773	32
15	99135	99218	99296	99370	99440	99506	99568	99626	99680	99729	99774	33
30	99137	99219	99297	99372	99442	99507	99569	99627	99680	99730	99775	34
45	99139	99220	99298	99373	99443	99509	99570	99628	99681	99731	99776	35
9 0	99140	99222	99300	99374	99444	99510	99571	99629	99682	99731	99776	36
15	99141	99223	99301	99375	99445	99511	99572	99630	99683	99732	99777	37
30	99142	99224	99303	99376	99446	99512	99573	99631	99684	99733	99778	38
45	99144	99226	99304	99378	99447	99513	99574	99631	99685	99734	99779	39
10 0	99145	99227	99305	99379	99448	99514	99575	99632	99686	99734	99779	40
15	99146	99228	99306	99380	99450	99515	99576	99633	99686	99735	99780	41
30	99148	99230	99308	99381	99451	99516	99577	99634	99687	99736	99781	42
45	99149	99231	99309	99382	99452	99517	99578	99635	99688	99737	99781	43
11 0	99151	99232	99310	99384	99453	99518	99579	99636	99689	99737	99782	44
15	99152	99234	99311	99385	99454	99519	99580	99637	99690	99738	99783	45
30	99153	99235	99312	99386	99455	99520	99581	99638	99691	99739	99784	46
45	99155	99236	99314	99387	99456	99521	99582	99639	99692	99740	99784	47
12 0	99156	99238	99315	99388	99457	99522	99583	99640	99692	99741	99785	48
15	99158	99239	99316	99389	99459	99523	99584	99641	99693	99741	99786	49
30	99159	99240	99318	99391	99460	99524	99585	99642	99694	99742	99786	50
45	99160	99242	99319	99392	99461	99525	99586	99642	99695	99743	99787	51
13 0	99162	99243	99320	99393	99462	99526	99587	99643	99696	99744	99788	52
15	99163	99244	99321	99394	99463	99527	99588	99644	99697	99744	99788	53
30	99165	99246	99323	99395	99464	99529	99589	99645	99697	99745	99789	54
45	99166	99247	99324	99397	99465	99530	99590	99646	99698	99746	99790	55
14 0	99167	99248	99325	99398	99466	99531	99591	99647	99699	99747	99790	56
15	99169	99250	99326	99399	99467	99532	99592	99648	99700	99748	99791	57
30	99170	99251	99328	99400	99469	99533	99593	99649	99701	99748	99792	58
45	99172	99252	99329	99401	99470	99534	99594	99650	99702	99749	99793	59

	Sec.	1″	2	3″	4″	5″	6″	7″	8″	9″	10″	11	12″	13	14″	15″
D. 1.	Parts	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

LOG. SINE SQUARE

	177°		178°				179°				
	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	
	$11^{h}50^{m}$	$11^{h}51^{m}$	$11^{h}52^{m}$	$11^{h}53^{m}$	$11^{h}54^{m}$	$11^{h}55^{m}$	$11^{h}56^{m}$	$11^{h}57^{m}$	$11^{h}58^{m}$	$11^{h}59^{m}$	s.
′ ″	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9	9·9		
0 0	99793	99833	99868	99899	99926	99948	99967	99981	99992	9·999998	0
15	99794	99833	99868	99899	99926	99949	99967	99982	99992	9·999998	1
30	99795	99834	99869	99900	99926	99949	99967	99982	99992	9·999998	2
45	99795	99834	99869	99900	99927	99949	99968	99982	99992	9·999998	3
1 0	99796	99835	99870	99901	99927	99950	99968	99982	99992	9·999998	4
15	99797	99836	99870	99901	99928	99950	99968	99982	99992	9·999998	5
30	99797	99836	99871	99902	99928	99950	99969	99983	99993	9·999998	6
45	99798	99837	99871	99902	99928	99951	99969	99983	99993	9·999998	7
2 0	99799	99838	99872	99903	99929	99951	99969	99983	99993	9·999998	8
15	99799	99838	99873	99903	99929	99951	99969	99983	99993	9·999998	9
30	99800	99839	99873	99903	99930	99952	99970	99983	99993	9·999998	10
45	99801	99839	99874	99904	99930	99952	99970	99984	99993	9·999998	11
3 0	99801	99840	99874	99904	99930	99952	99970	99984	99993	9·999999	12
15	99802	99841	99875	99905	99931	99953	99970	99984	99993	9·999999	13
30	99803	99841	99875	99905	99931	99953	99971	99984	99994	9·999999	14
45	99804	99842	99876	99906	99932	99953	99971	99984	99994	9·999999	15
4 0	99804	99842	99876	99906	99932	99954	99971	99985	99994	9·999999	16
15	99805	99843	99877	99907	99932	99954	99971	99985	99994	9·999999	17
30	99806	99844	99877	99907	99933	99954	99972	99985	99994	9·999999	18
45	99806	99844	99878	99908	99933	99955	99972	99985	99994	9·999999	19
5 0	99807	99845	99878	99908	99934	99955	99972	99985	99994	9·999999	20
15	99808	99845	99879	99908	99934	99955	99972	99985	99994	9·999999	21
30	99808	99846	99880	99909	99934	99956	99973	99986	99994	9·999999	22
45	99809	99846	99880	99909	99935	99956	99973	99986	99994	9·999999	23
6 0	99810	99847	99881	99910	99935	99956	99973	99986	99995	9·999999	24
15	99810	99848	99881	99910	99936	99957	99973	99986	99995	9·999999	25
30	99811	99848	99882	99911	99936	99957	99974	99986	99995	9·999999	26
45	99811	99849	99882	99911	99936	99957	99974	99987	99995	9·999999	27
7 0	99812	99849	99883	99912	99937	99958	99974	99987	99995	9·999999	28
15	99813	99850	99883	99912	99937	99958	99974	99987	99995	9·999999	29
30	99813	99851	99884	99913	99937	99958	99975	99987	99995	9·999999	30
45	99814	99851	99884	99913	99938	99958	99975	99987	99995	9·999999	31
8 0	99815	99852	99885	99914	99938	99959	99975	99987	99996	9·999999	32
15	99815	99852	99885	99914	99939	99959	99975	99988	99996	9·999999	33
30	99816	99853	99886	99914	99939	99959	99976	99988	99996	9·999999	34
45	99817	99854	99886	99915	99939	99960	99976	99988	99996	10·000000	35
9 0	99817	99854	99887	99915	99940	99960	99976	99988	99996	10·000000	36
15	99818	99855	99887	99916	99940	99960	99976	99988	99996	10·000000	37
30	99819	99855	99888	99916	99940	99961	99977	99988	99996	10·000000	38
45	99819	99856	99888	99917	99941	99961	99977	99989	99996	10·000000	39
10 0	99820	99856	99889	99917	99941	99961	99977	99989	99996	10·000000	40
15	99821	99857	99889	99918	99942	99961	99977	99989	99996	10·000000	41
30	99821	99858	99890	99918	99942	99962	99977	99989	99996	10·000000	42
45	99822	99858	99890	99918	99942	99962	99978	99989	99997	10·000000	43
11 0	99822	99859	99891	99919	99943	99962	99978	99989	99997	10·000000	44
15	99823	99859	99891	99919	99943	99963	99978	99990	99997	10·000000	45
30	99824	99860	99892	99920	99943	99963	99978	99990	99997	10·000000	46
45	99824	99860	99892	99920	99944	99963	99979	99990	99997	10·000000	47
12 0	99825	99861	99893	99920	99944	99964	99979	99990	99997	10·000000	48
15	99826	99862	99893	99921	99944	99964	99979	99990	99997	10·000000	49
30	99826	99862	99894	99921	99945	99964	99979	99990	99997	10·000000	50
45	99827	99863	99894	99922	99945	99964	99979	99990	99997	10·000000	51
13 0	99827	99863	99895	99922	99946	99965	99980	99991	99997	10·000000	52
15	99828	99864	99895	99923	99946	99965	99980	99991	95997	10·000000	53
30	99829	99864	99896	99923	99946	99965	99980	99991	99997	10·000000	54
45	99829	99865	99896	99923	99947	99966	99980	99991	99998	10·000000	55
14 0	99830	99865	99897	99924	99947	99966	99981	99991	99998	10·000000	56
15	99831	99866	99897	99924	99947	99966	99981	99991	99998	10·000000	57
30	99831	99866	99898	99925	99948	99966	99981	99991	99998	10·000000	58
45	99832	99867	99868	99925	99948	99967	99981	99992	99998	10·000000	59

LOGARITHMS
FOR COMPUTING THE REDUCTION TO THE MERIDIAN, AT SEA.
Part I. Latitude and Declination of the *same* name.

Lat.	Declination.											Lat.
	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	
0°						1·359	1·279	1·212	1·153	1·101	1·055	1·012	0°
1							1·358	1·278	1·211	1·152	1·100	1·053	1
2								1·357	1·277	1·209	1·151	1·098	2
3									1·356	1·276	1·208	1·149	3
4										1·354	1·274	1·206	4
5	1·359										1·352	1·272	5
6	1·279	1·358										1·350	6
7	1·212	1·278	1·357										7
8	1·153	1·211	1·277	1·356									8
9	1·101	1·152	1·209	1·276	1·354								9
10	1·055	1·100	1·151	1·208	1·274	1·352							10
11	1·012	1·053	1·098	1·149	1·206	1·272	1·350						11
12	0·974	1·011	1·051	1·097	1·147	1·204	1·270	1·348					12
13	0·938	0·972	1·009	1·049	1·094	1·145	1·201	1·267	1·345				13
14	0·904	0·936	0·970	1·007	1·047	1·092	1·142	1·199	1·264	1·342			14
15	0·873	0·902	0·934	0·967	1·004	1·045	1·089	1·139	1·196	1·261	1·339		15
16	0·844	0·871	0·900	0·931	0·965	1·002	1·042	1·086	1·136	1·193	1·258	1·336	16
17	0·816	0·841	0·868	0·897	0·928	0·962	0·999	1·039	1·083	1·133	1·189	1·254	17
18	0·789	0·813	0·839	0·866	0·895	0·925	0·959	0·995	1·035	1·080	1·129	1·185	18
19	0·764	0·787	0·811	0·836	0·863	0·891	0·922	0·956	0·992	1·032	1·076	1·125	19
20	0·740	0·761	0·784	0·807	0·833	0·859	0·888	0·919	0·952	0·988	1·028	1·072	20
21	0·717	0·737	0·758	0·781	0·804	0·829	0·856	0·884	0·915	0·948	0·984	1·023	21
22	0·695	0·714	0·734	0·755	0·777	0·801	0·825	0·852	0·880	0·911	0·944	0·980	22
23	0·673	0·691	0·710	0·730	0·751	0·773	0·797	0·821	0·848	0·876	0·906	0·939	23
24	0·652	0·670	0·688	0·707	0·727	0·747	0·769	0·793	0·817	0·844	0·871	0·902	24
25	0·632	0·649	0·666	0·684	0·703	0·723	0·743	0·765	0·788	0·813	0·839	0·867	25
26	0·613	0·629	0·645	0·662	0·680	0·699	0·718	0·739	0·760	0·783	0·808	0·834	26
27	0·594	0·609	0·625	0·641	0·658	0·676	0·694	0·714	0·734	0·756	0·778	0·803	27
28	0·575	0·590	0·605	0·620	0·637	0·653	0·671	0·689	0·709	0·729	0·750	0·773	28
29	0·557	0·571	0·586	0·600	0·616	0·632	0·649	0·666	0·684	0·703	0·724	0·745	29
30	0·540	0·553	0·567	0·581	0·596	0·611	0·627	0·643	0·661	0·679	0·698	0·718	30
31	0·522	0·535	0·548	0·562	0·576	0·591	0·606	0·622	0·638	0·655	0·673	0·692	31
32	0·505	0·518	0·530	0·543	0·557	0·571	0·585	0·600	0·616	0·632	0·649	0·667	32
33	0·489	0·500	0·513	0·525	0·538	0·551	0·565	0·580	0·594	0·610	0·626	0·643	33
34	0·472	0·483	0·495	0·507	0·519	0·532	0·546	0·559	0·574	0·588	0·604	0·620	34
35	0·456	0·467	0·478	0·489	0·501	0·514	0·526	0·540	0·553	0·567	0·582	0·597	35
36	0·440	0·450	0·461	0·472	0·484	0·495	0·508	0·520	0·533	0·548	0·560	0·575	36
37	0·424	0·434	0·445	0·455	0·466	0·478	0·489	0·501	0·514	0·526	0·540	0·553	37
38	0·408	0·418	0·428	0·438	0·449	0·460	0·471	0·482	0·494	0·507	0·519	0·532	38
39	0·393	0·402	0·412	0·422	0·432	0·442	0·453	0·464	0·475	0·487	0·499	0·512	39
40	0·377	0·386	0·396	0·405	0·415	0·425	0·435	0·447	0·457	0·468	0·480	0·492	40
41	0·362	0·371	0·380	0·389	0·398	0·408	0·418	0·428	0·438	0·449	0·460	0·472	41
42	0·347	0·355	0·364	0·373	0·382	0·391	0·400	0·410	0·420	0·431	0·441	0·452	42
43	0·331	0·340	0·348	0·356	0·365	0·374	0·383	0·393	0·402	0·412	0·422	0·433	43
44	0·316	0·324	0·332	0·340	0·349	0·357	0·366	0·375	0·384	0·394	0·404	0·414	44
45	0·301	0·309	0·316	0·324	0·333	0·341	0·349	0·358	0·367	0·376	0·385	0·395	45
46	0·286	0·293	0·301	0·308	0·316	0·324	0·332	0·341	0·349	0·358	0·367	0·376	46
47	0·271	0·278	0·285	0·292	0·300	0·308	0·315	0·323	0·331	0·340	0·349	0·358	47
48	0·255	0·262	0·269	0·276	0·284	0·291	0·299	0·306	0·314	0·322	0·331	0·339	48
49	0·240	0·247	0·254	0·260	0·267	0·275	0·282	0·289	0·297	0·305	0·312	0·321	49
50	0·225	0·231	0·238	0·244	0·251	0·258	0·265	0·272	0·279	0·287	0·294	0·302	50
51	0·209	0·216	0·222	0·228	0·235	0·241	0·248	0·255	0·262	0·269	0·276	0·284	51
52	0·194	0·200	0·206	0·212	0·218	0·225	0·231	0·238	0·244	0·251	0·258	0·265	52
53	0·178	0·184	0·190	0·196	0·202	0·208	0·214	0·220	0·227	0·233	0·140	0·247	53
54	0·162	0·168	0·173	0·179	0·185	0·191	0·197	0·203	0·209	0·215	0·222	0·228	54
55	0·146	0·152	0·157	0·162	0·168	0·174	0·179	0·185	0·191	0·197	0·204	0·210	55
56	0·130	0·135	0·140	0·146	0·151	0·156	0·162	0·168	0·173	0·179	0·185	0·191	56
57	0·114	0·118	0·124	0·129	0·134	0·139	0·144	0·150	0·155	0·160	0·166	0·172	57
58	0·097	0·100	0·106	0·111	0·116	0·121	0·126	0·131	0·137	0·142	0·148	0·153	58
59	0·080	0·084	0·089	0·094	0·098	0·103	0·108	0·113	0·118	0·123	0·128	0·134	59
60	0·062	0·067	0·071	0·076	0·080	0·085	0·090	0·094	0·099	0·104	0·109	0·114	60
61	0·045	0·049	0·053	0·058	0·062	0·066	0·071	0·075	0·080	0·085	0·089	0·094	61
62	0·027	0·031	0·035	0·039	0·043	0·047	0·052	0·056	0·060	0·065	0·069	0·074	62

LOGARITHMS
FOR COMPUTING THE REDUCTION TO THE MERIDIAN, AT SEA.
PART I. Latitude and Declination of the *same* name.

Lat.	Declination.												Lat.
	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	
0°	0·974	0·938	0·904	0·873	0·844	0·816	0·789	0·764	0·740	0·717	0·695	0·673	0°
1	1·011	0·972	0·936	0·902	0·871	0·841	0·813	0·787	0·761	0·737	0·714	0·691	1
2	1·051	1·009	0·970	0·934	0·900	0·868	0·839	0·811	0·784	0·758	0·734	0·710	2
3	1·097	1·049	1·007	0·967	0·931	0·897	0·866	0·836	0·807	0·781	0·755	0·730	3
4	1·147	1·094	1·047	1·004	0·965	0·928	0·895	0·863	0·833	0·804	0·777	0·751	4
5	1·204	1·145	1·092	1·045	1·002	0·962	0·925	0·891	0·859	0·829	0·801	0·773	5
6	1·270	1·201	1·142	1·089	1·042	0·999	0·959	0·922	0·888	0·856	0·825	0·797	6
7	1·348	1·267	1·199	1·139	1·086	1·039	0·995	0·956	0·919	0·884	0·852	0·821	7
8		1·345	1·264	1·196	1·136	1·083	1·035	0·992	0·952	0·915	0·880	0·848	8
9			1·342	1·261	1·193	1·133	1·080	1·032	0·988	0·948	0·911	0·876	9
10				1·339	1·258	1·189	1·129	1·076	1·028	0·984	0·944	0·906	10
11					1·336	1·254	1·185	1·125	1·072	1·023	0·980	0·939	11
12						1·332	1·250	1·181	1·121	1·067	1·019	0·975	12
13							1·328	1·246	1·177	1·116	1·063	1·014	13
14								1·323	1·242	1·172	1·112	1·058	14
15									1·319	1·237	1·167	1·106	15
16										1·314	1·232	1·162	16
17	1·332										1·308	1·226	17
18	1·250	1·328										1·303	18
19	1·181	1·246	1·323										19
20	1·121	1·177	1·242	1·319									20
21	1·067	1·116	1·172	1·237	1·314								21
22	1·019	1·063	1·112	1·167	1·232	1·308							22
23	0·975	1·014	1·058	1·106	1·162	1·226	1·303						23
24	0·934	0·970	1·009	1·052	1·101	1·156	1·221	1·297					24
25	0·897	0·929	0·965	1·004	1·047	1·095	1·151	1·215	1·291				25
26	0·861	0·890	0·924	0·959	0·998	1·041	1·090	1·144	1·208	1·285			26
27	0·828	0·856	0·886	0·918	0·953	0·992	1·035	1·083	1·138	1·202	1·278		27
28	0·797	0·823	0·850	0·880	0·912	0·947	0·986	1·028	1·076	1·131	1·195	1·271	28
29	0·767	0·791	0·817	0·844	0·874	0·906	0·940	0·979	1·021	1·069	1·124	1·188	29
30	0·739	0·761	0·785	0·811	0·838	0·867	0·899	0·934	0·972	1·014	1·062	1·117	30
31	0·712	0·733	0·755	0·779	0·804	0·831	0·860	0·892	0·926	0·965	1·007	1·055	31
32	0·686	0·706	0·726	0·748	0·772	0·797	0·824	0·853	0·885	0·919	0·957	0·999	32
33	0·661	0·679	0·699	0·720	0·742	0·765	0·790	0·817	0·846	0·877	0·911	0·949	33
34	0·636	0·654	0·672	0·692	0·712	0·734	0·757	0·782	0·809	0·838	0·869	0·903	34
35	0·612	0·630	0·647	0·665	0·685	0·705	0·727	0·750	0·774	0·801	0·829	0·861	35
36	0·590	0·606	0·622	0·640	0·658	0·677	0·697	0·719	0·742	0·766	0·792	0·821	36
37	0·568	0·583	0·598	0·615	0·632	0·650	0·669	0·689	0·710	0·733	0·758	0·784	37
38	0·546	0·560	0·575	0·591	0·607	0·624	0·642	0·661	0·681	0·702	0·724	0·749	38
39	0·525	0·538	0·552	0·567	0·582	0·599	0·615	0·633	0·652	0·672	0·693	0·715	39
40	0·504	0·517	0·530	0·544	0·559	0·574	0·590	0·607	0·624	0·643	0·662	0·683	40
41	0·484	0·496	0·509	0·522	0·536	0·550	0·565	0·581	0·597	0·615	0·633	0·653	41
42	0·464	0·475	0·487	0·500	0·513	0·527	0·541	0·556	0·572	0·588	0·605	0·623	42
43	0·444	0·455	0·466	0·478	0·491	0·504	0·517	0·532	0·546	0·562	0·578	0·595	43
44	0·424	0·435	0·446	0·457	0·469	0·482	0·494	0·508	0·522	0·536	0·552	0·568	44
45	0·405	0·415	0·426	0·436	0·448	0·460	0·472	0·484	0·498	0·511	0·526	0·541	45
46	0·386	0·395	0·405	0·416	0·427	0·438	0·449	0·461	0·474	0·487	0·501	0·515	46
47	0·367	0·376	0·386	0·396	0·406	0·416	0·427	0·439	0·451	0·463	0·476	0·490	47
48	0·348	0·357	0·366	0·375	0·385	0·395	0·406	0·417	0·428	0·440	0·452	0·465	48
49	0·329	0·337	0·346	0·355	0·365	0·374	0·384	0·395	0·405	0·417	0·428	0·440	49
50	0·310	0·318	0·327	0·335	0·344	0·354	0·363	0·373	0·383	0·394	0·405	0·416	50
51	0·291	0·299	0·307	0·316	0·324	0·333	0·342	0·351	0·361	0·371	0·381	0·392	51
52	0·273	0·280	0·288	0·296	0·304	0·312	0·321	0·330	0·339	0·349	0·359	0·369	52
53	0·254	0·261	0·269	0·276	0·284	0·292	0·300	0·309	0·317	0·326	0·336	0·346	53
54	0·235	0·242	0·249	0·257	0·264	0·271	0·279	0·287	0·296	0·304	0·313	0·322	54
55	0·216	0·223	0·230	0·236	0·244	0·251	0·258	0·266	0·274	0·282	0·291	0·299	55
56	0·197	0·204	0·210	0·217	0·223	0·230	0·237	0·245	0·252	0·260	0·268	0·277	56
57	0·178	0·184	0·190	0·197	0·203	0·210	0·216	0·223	0·231	0·238	0·246	0·254	57
58	0·159	0·164	0·170	0·176	0·183	0·189	0·195	0·202	0·209	0·216	0·223	0·231	58
59	0·139	0·145	0·150	0·156	0·162	0·168	0·174	0·180	0·187	0·194	0·201	0·208	59
60	0·119	0·125	0·130	0·135	0·141	0·147	0·153	0·159	0·165	0·171	0·178	0·185	60
61	0·099	0·104	0·109	0·115	0·120	0·125	0·131	0·137	0·143	0·149	0·155	0·161	61
62	0·079	0·084	0·088	0·093	0·099	0·104	0·110	0·115	0·120	0·126	0·132	0·138	62

LOGARITHMS
FOR COMPUTING THE REDUCTION TO THE MERIDIAN, AT SEA.
PART I. Latitude and Declination of the *same* name.

Lat.	Declination.												Lat.
	24°	25°	26°	27°	28°	29°	30°	31°	32°	33°	34°	35°	
0°	0·652	0·632	0·613	0·594	0·575	0·557	0·539	0·522	0·505	0·489	0·472	0·456	0°
1	0·670	0·649	0·629	0·609	0·590	0·571	0·553	0·535	0·518	0·501	0·484	0·467	1
2	0·688	0·666	0·645	0·625	0·605	0·586	0·567	0·548	0·530	0·513	0·496	0·478	2
3	0·707	0·684	0·662	0·641	0·621	0·601	0·581	0·562	0·543	0·525	0·508	0·490	3
4	0·727	0·703	0·680	0·658	0·637	0·616	0·596	0·576	0·557	0·538	0·520	0·502	4
5	0·747	0·723	0·699	0·676	0·654	0·632	0·611	0·591	0·571	0·551	0·532	0·514	5
6	0·769	0·743	0·718	0·694	0·671	0·649	0·627	0·606	0·585	0·565	0·545	0·526	6
7	0·793	0·765	0·739	0·714	0·689	0·666	0·644	0·622	0·601	0·580	0·559	0·539	7
8	0·817	0·788	0·760	0·734	0·709	0·684	0·661	0·638	0·616	0·595	0·574	0·553	8
9	0·844	0·813	0·783	0·755	0·729	0·704	0·679	0·655	0·632	0·610	0·589	0·567	9
10	0·872	0·839	0·808	0·778	0·750	0·724	0·6[illegible]8	0·673	0·649	0·626	0·604	0·582	10
11	0·902	0·867	0·834	0·803	0·773	0·745	0·718	0·692	0·667	0·643	0·620	0·597	11
12	0·935	0·897	0·862	0·829	0·797	0·767	0·739	0·712	0·686	0·661	0·637	0·613	12
13	0·970	0·930	0·892	0·857	0·823	0·791	0·761	0·733	0·706	0·680	0·654	0·630	13
14	1·010	0·965	0·924	0·886	0·850	0·817	0·785	0·755	0·726	0·699	0·673	0·647	14
15	1·053	1·004	0·959	0·918	0·880	0·844	0·811	0·779	0·749	0·720	0·692	0·665	15
16	1·101	1·047	0·998	0·953	0·911	0·874	0·838	0·804	0·772	0·742	0·713	0·685	16
17	1·157	1·096	1·041	0·992	0·947	0·905	0·867	0·831	0·797	0·765	0·735	0·705	17
18	1·222	1·151	1·089	1·035	0·986	0·940	0·898	0·860	0·824	0·790	0·758	0·727	18
19	1·297	1·216	1·145	1·083	1·029	0·980	0·934	0·891	0·853	0·817	0·782	0·750	19
20		1·291	1·210	1·138	1·076	1·022	0·973	0·927	0·884	0·846	0·809	0·774	20
21			1·285	1·203	1·131	1·069	1·015	0·965	0·919	0·877	0·838	0·800	21
22				1·278	1·196	1·124	1·061	1·007	0·957	0·911	0·868	0·829	22
23					1·271	1·189	1·117	1·054	0·999	0·949	0·903	0·860	23
24						1·264	1·182	1·109	1·046	0·991	0·941	0·894	24
25							1·256	1·173	1·101	1·038	0·983	0·933	25
26								1·248	1·165	1·092	1·029	0·974	26
27									1·239	1·156	1·083	1·020	27
28										1·230	1·147	1·074	28
29	1·264										1·221	1·138	29
30	1·1[illegible]2	1·256										1·212	30
31	1·109	1·174	1·248										31
32	1·046	1·101	1·166	1·2[illegible]9									32
33	0·991	1·038	1·093	1·157	1·230								33
34	0·941	0·983	1·030	1·0[illegible]4	1·147	1·221							34
35	0·895	0·933	0·974	1·021	1·075	1·138	1·212						35
36	0·852	0·886	0·924	0·965	1·012	1·065	1·128	1·202					36
37	0·812	0·843	0·877	0·914	0·955	1·002	1·055	1·118	1·191				37
38	0·775	0·803	0·834	0·867	0·904	0·945	0·992	1·045	1·107	1·181			38
39	0·740	0·765	0·793	0·823	0·857	0·894	0·935	0·982	1·034	1·097	1·170		39
40	0·706	0·730	0·755	0·783	0·814	0·847	0·883	0·924	0·970	1·023	1·086	1·158	40
41	0·673	0·696	0·719	0·745	0·773	0·803	0·836	0·872	0·914	0·958	1·012	1·075	41
42	0·642	0·663	0·685	0·709	0·734	0·762	0·792	0·825	0·861	0·901	0·947	1·000	42
43	0·613	0·632	0·653	0·675	0·698	0·723	0·751	0·781	0·813	0·849	0·889	0·934	43
44	0·585	0·602	0·621	0·642	0·664	0·687	0·712	0·739	0·769	0·801	0·837	0·877	44
45	0·557	0·574	0·591	0·610	0·631	0·652	0·675	0·700	0·727	0·756	0·789	0·825	45
46	0·530	0·546	0·562	0·580	0·599	0·619	0·640	0·663	0·687	0·714	0·744	0·776	46
47	0·504	0·519	0·534	0·551	0·568	0·587	0·607	0·628	0·650	0·675	0·701	0·731	47
48	0·478	0·492	0·507	0·522	0·539	0·556	0·575	0·594	0·615	0·637	0·662	0·688	48
49	0·453	0·466	0·480	0·494	0·510	0·526	0·543	0·561	0·581	0·601	0·624	0·648	49
50	0·428	0·440	0·453	0·467	0·482	0·497	0·513	0·530	0·548	0·567	0·588	0·610	50
51	0·403	0·415	0·427	0·440	0·454	0·468	0·483	0·499	0·516	0·534	0·553	0·573	51
52	0·379	0·390	0·402	0·414	0·427	0·440	0·454	0·469	0·485	0·501	0·519	0·538	52
53	0·356	0·366	0·377	0·388	0·400	0·413	0·426	0·440	0·454	0·470	0·486	0·504	53
54	0·332	0·342	0·352	0·363	0·374	0·386	0·398	0·411	0·425	0·439	0·455	0·471	54
55	0·308	0·318	0·328	0·338	0·348	0·359	0·371	0·383	0·396	0·410	0·424	0·438	55
56	0·285	0·294	0·303	0·313	0·322	0·333	0·344	0·356	0·368	0·380	0·394	0·408	56
57	0·262	0·270	0·279	0·288	0·297	0·307	0·317	0·328	0·340	0·352	0·364	0·377	57
58	0·238	0·246	0·254	0·263	0·272	0·281	0·291	0·301	0·312	0·323	0·335	0·347	58
59	0·215	0·222	0·230	0·238	0·247	0·255	0·264	0·274	0·284	0·295	0·306	0·317	59
60	0·191	0·198	0·205	0·213	0·221	0·230	0·238	0·247	0·257	0·267	0·277	0·288	60
61	0·168	0·174	0·181	0·188	0·196	0·204	0·212	0·220	0·229	0·238	0·248	0·258	61
62	0·144	0·150	0·157	0·164	0·171	0·178	0·186	0·194	0·202	0·211	0·220	0·229	62

LOGARITHMS
FOR COMPUTING THE REDUCTION TO THE MERIDIAN, AT SEA.
PART II. Latitude and Declination of *contrary* Names.

Lat.	Declination. 0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	Lat.
0°						1·359	1·279	1·212	1·153	1·101	1·055	1·012	0
1					1·360	1·280	1·213	1·154	1·102	1·056	1·014	0·975	1
2				1·360	1·281	1·213	1·155	1·103	1·057	1·015	0·976	0·941	2
3			1·360	1·281	1·213	1·155	1·104	1·058	1·016	0·977	0·942	0·909	3
4		1·360	1·280	1·213	1·155	1·104	1·058	1·016	0·978	0·943	0·910	0·879	4
5	1·359	1·280	1·213	1·155	1·104	1·058	1·016	0·978	0·943	0·910	0·880	0·851	5
6	1·279	1·213	1·155	1·104	1·058	1·016	0·979	0·943	0·911	0·880	0·852	0·825	6
7	1·212	1·154	1·103	1·058	1·016	0·978	0·943	0·911	0·881	0·851	0·825	0·800	7
8	1·153	1·102	1·057	1·016	0·978	0·943	0·911	0·881	0·852	0·825	0·800	0·776	8
9	1·101	1·056	1·015	0·977	0·943	0·910	0·880	0·852	0·825	0·800	0·776	0·754	9
10	1·055	1·014	0·976	0·942	0·910	0·880	0·852	0·825	0·800	0·776	0·754	0·732	10
11	1·012	0·975	0·941	0·909	0·879	0·851	0·825	0·800	0·776	0·754	0·732	0·711	11
12	0·974	0·939	0·907	0·878	0·850	0·824	0·799	0·775	0·753	0·732	0·711	0·692	12
13	0·938	0·906	0·876	0·849	0·823	0·798	0·775	0·752	0·731	0·711	0·691	0·672	13
14	0·904	0·875	0·847	0·821	0·797	0·774	0·751	0·730	0·710	0·691	0·672	0·654	14
15	0·873	0·846	0·820	0·795	0·772	0·750	0·729	0·709	0·690	0·671	0·653	0·636	15
16	0·844	0·818	0·794	0·771	0·749	0·728	0·708	0·689	0·670	0·653	0·635	0·619	16
17	0·816	0·792	0·769	0·747	0·726	0·706	0·687	0·669	0·651	0·634	0·617	0·602	17
18	0·789	0·767	0·745	0·724	0·705	0·686	0·668	0·650	0·633	0·617	0·601	0·586	18
19	0·764	0·743	0·722	0·703	0·684	0·666	0·648	0·632	0·615	0·600	0·584	0·570	19
20	0·740	0·720	0·700	0·682	0·664	0·646	0·630	0·614	0·598	0·583	0·568	0·554	20
21	0·717	0·698	0·679	0·661	0·644	0·628	0·612	0·596	0·581	0·567	0·553	0·539	1
22	0·695	0·676	0·659	0·642	0·625	0·609	0·594	0·579	0·565	0·551	0·537	0·524	22
23	0·673	0·656	0·639	0·623	0·607	0·592	0·577	0·563	0·549	0·535	0·522	0·509	23
24	0·652	0·636	0·621	0·604	0·589	0·575	0·560	0·547	0·533	0·520	0·508	0·495	24
25	0·632	0·616	0·601	0·586	0·572	0·558	0·544	0·531	0·518	0·505	0·493	0·481	25
26	0·613	0·598	0·583	0·569	0·555	0·541	0·528	0·515	0·503	0·491	0·479	0·467	26
27	0·594	0·579	0·565	0·551	0·538	0·525	0·512	0·500	0·488	0·476	0·465	0·454	27
28	0·575	0·561	0·548	0·535	0·522	0·509	0·497	0·485	0·473	0·462	0·451	0·440	28
29	0·557	0·544	0·531	0·518	0·506	0·494	0·482	0·470	0·459	0·448	0·437	0·427	29
30	0·540	0·527	0·514	0·502	0·490	0·478	0·467	0·456	0·445	0·434	0·425	0·414	30
31	0·522	0·510	0·498	0·486	0·474	0·463	0·452	0·442	0·431	0·421	0·411	0·401	31
32	0·505	0·493	0·482	0·470	0·459	0·448	0·438	0·427	0·417	0·407	0·397	0·388	32
33	0·489	0·477	0·466	0·455	0·444	0·434	0·423	0·413	0·403	0·394	0·384	0·375	33
34	0·472	0·461	0·450	0·440	0·429	0·419	0·409	0·399	0·390	0·380	0·371	0·362	34
35	0·456	0·445	0·435	0·424	0·414	0·405	0·395	0·386	0·376	0·367	0·358	0·349	35
36	0·440	0·429	0·419	0·410	0·400	0·390	0·381	0·372	0·363	0·354	0·345	0·337	36
37	0·424	0·414	0·404	0·395	0·385	0·376	0·367	0·358	0·350	0·341	0·333	0·324	37
38	0·408	0·399	0·389	0·380	0·371	0·362	0·353	0·345	0·336	0·328	0·320	0·312	38
39	0·393	0·384	0·374	0·365	0·357	0·348	0·340	0·331	0·323	0·315	0·307	0·299	39
40	0·377	0·368	0·360	0·351	0·342	0·334	0·326	0·318	0·310	0·302	0·294	0·287	40
41	0·362	0·353	0·345	0·336	0·328	0·320	0·312	0·304	0·297	0·289	0·282	0·274	41
42	0·347	0·338	0·330	0·322	0·314	0·306	0·299	0·291	0·284	0·276	0·269	0·262	42
43	0·331	0·323	0·315	0·308	0·300	0·292	0·285	0·278	0·270	0·263	0·256	0·249	43
44	0·316	0·308	0·301	0·293	0·286	0·279	0·271	0·264	0·257	0·250	0·243	0·237	44
45	0·301	0·294	0·286	0·279	0·272	0·265	0·258	0·251	0·244	0·237	0·231	0·224	45
46	0·286	0·279	0·271	0·264	0·257	0·251	0·244	0·237	0·231	0·224	0·218	0·211	46
47	0·271	0·264	0·257	0·250	0·243	0·237	0·230	0·224	0·217	0·211	0·205	0·198	47
48	0·255	0·249	0·242	0·235	0·229	0·223	0·216	0·210	0·204	0·198	0·191	0·185	48
49	0·240	0·234	0·227	0·221	0·215	0·208	0·202	0·196	0·190	0·184	0·178	0·172	49
50	0·225	0·219	0·212	0·206	0·200	0·194	0·188	0·182	0·176	0·171	0·165	0·159	50
51	0·209	0·203	0·197	0·191	0·185	0·180	0·174	0·168	0·163	0·157	0·151	0·145	51
52	0·194	0·188	0·182	0·176	0·171	0·165	0·160	0·154	0·149	0·143	0·138	0·132	52
53	0·178	0·172	0·167	0·161	0·156	0·150	0·145	0·140	0·134	0·129	0·124	0·119	53
54	0·162	0·157	0·151	0·146	0·141	0·136	0·130	0·125	0·120	0·115	0·110	0·105	54
55	0·146	0·141	0·136	0·131	0·125	0·120	0·115	0·110	0·105	0·101	0·096	0·091	55
56	0·130	0·125	0·120	0·115	0·110	0·105	0·100	0·095	0·091	0·086	0·081	0·077	56
57	0·114	0·109	0·104	0·099	0·094	0·090	0·085	0·080	0·076	0·071	0·066	0·062	57
58	0·097	0·092	0·087	0·083	0·078	0·074	0·069	0·065	0·060	0·056	0·051	0·047	58
59	0·080	0·075	0·071	0·066	0·062	0·058	0·053	0·049	0·045	0·040	0·036	0·032	59
60	0·062	0·058	0·054	0·050	0·045	0·041	0·037	0·033	0·029	0·024	0·020	0·016	60
61	0·045	0·041	0·036	0·032	0·028	0·024	0·020	0·016	0·012	0·008	0·004	0·000	61
62	0·027	0·023	0·019	0·015	0·011	0·007	0·003	9·999	9·995	9·992	9·988	9·984	62

LOGARITHMS
FOR COMPUTING THE REDUCTION TO THE MERIDIAN, AT SEA
Part II. Latitude and Declination of *contrary* Names.

Lat.	Declination. 12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	Lat.
0°	0·974	0·938	0·904	0·873	0·844	0·816	0·789	0·764	0·740	0·717	0·695	0·673	0°
1	0·939	0·906	0·875	0·846	0·818	0·792	0·767	0·743	0·720	0·698	0·676	0·656	1
2	0·907	0·876	0·847	0·820	0·794	0·769	0·745	0·722	0·700	0·679	0·659	0·639	2
3	0·878	0·849	0·821	0·795	0·771	0·747	0·724	0·703	0·682	0·661	0·642	0·623	3
4	0·850	0·823	0·797	0·772	0·749	0·726	0·705	0·684	0·664	0·644	0·625	0·607	4
5	0·824	0·798	0·774	0·750	0·728	0·706	0·686	0·666	0·646	0·628	0·609	0·592	5
6	0·799	0·775	0·751	0·729	0·708	0·687	0·668	0·648	0·630	0·612	0·594	0·577	6
7	0·776	0·752	0·730	0·709	0·689	0·669	0·650	0·632	0·614	0·596	0·579	0·563	7
8	0·753	0·731	0·710	0·690	0·670	0·651	0·633	0·615	0·598	0·581	0·565	0·549	8
9	0·732	0·711	0·691	0·671	0·653	0·634	0·617	0·600	0·583	0·567	0·551	0·535	9
10	0·711	0·691	0·672	0·653	0·635	0·618	0·601	0·584	0·568	0·553	0·537	0·522	10
11	0·692	0·672	0·654	0·636	0·619	0·602	0·586	0·570	0·554	0·539	0·524	0·509	11
12	0·673	0·654	0·636	0·619	0·603	0·586	0·571	0·555	0·540	0·525	0·511	0·497	12
13	0·654	0·637	0·620	0·603	0·587	0·571	0·556	0·541	0·527	0·512	0·498	0·485	13
14	0·636	0·620	0·603	0·587	0·572	0·557	0·542	0·527	0·513	0·499	0·486	0·473	14
15	0·619	0·602	0·587	0·572	0·557	0·542	0·528	0·514	0·500	0·487	0·474	0·461	15
16	0·603	0·587	0·572	0·557	0·542	0·528	0·515	0·501	0·488	0·475	0·462	0·449	16
17	0·586	0·571	0·557	0·542	0·528	0·515	0·501	0·488	0·475	0·463	0·450	0·438	17
18	0·571	0·556	0·542	0·528	0·515	0·501	0·488	0·475	0·463	0·451	0·438	0·426	18
19	0·555	0·541	0·527	0·514	0·501	0·488	0·475	0·463	0·451	0·439	0·427	0·415	19
20	0·540	0·527	0·513	0·500	0·488	0·475	0·463	0·451	0·439	0·427	0·416	0·404	20
21	0·525	0·512	0·499	0·487	0·475	0·462	0·451	0·439	0·427	0·416	0·405	0·393	21
22	0·511	0·498	0·486	0·474	0·462	0·450	0·438	0·427	0·416	0·405	0·394	0·383	22
23	0·497	0·485	0·472	0·461	0·449	0·438	0·426	0·415	0·404	0·393	0·383	0·372	23
24	0·483	0·471	0·459	0·448	0·437	0·425	0·414	0·404	0·393	0·382	0·372	0·362	24
25	0·469	0·458	0·446	0·435	0·424	0·413	0·403	0·392	0·382	0·372	0·361	0·351	25
26	0·456	0·445	0·434	0·423	0·412	0·402	0·391	0·381	0·371	0·361	0·351	0·341	26
27	0·442	0·432	0·421	0·410	0·400	0·390	0·380	0·370	0·360	0·350	0·340	0·331	27
28	0·429	0·419	0·408	0·398	0·388	0·378	0·368	0·359	0·349	0·339	0·330	0·320	28
29	0·416	0·406	0·396	0·386	0·376	0·367	0·357	0·347	0·338	0·329	0·320	0·310	29
30	0·403	0·394	0·384	0·374	0·364	0·355	0·346	0·336	0·327	0·318	0·309	0·300	30
31	0·391	0·381	0·372	0·362	0·353	0·344	0·335	0·326	0·317	0·308	0·299	0·290	31
32	0·378	0·369	0·359	0·350	0·341	0·332	0·323	0·315	0·306	0·297	0·289	0·280	32
33	0·366	0·356	0·347	0·338	0·330	0·321	0·312	0·304	0·295	0·287	0·278	0·270	33
34	0·353	0·344	0·335	0·327	0·318	0·310	0·301	0·293	0·285	0·276	0·268	0·260	34
35	0·341	0·332	0·324	0·315	0·307	0·298	0·290	0·282	0·274	0·266	0·258	0·250	35
36	0·328	0·320	0·312	0·303	0·295	0·287	0·279	0·271	0·263	0·256	0·248	0·240	36
37	0·316	0·308	0·300	0·292	0·284	0·276	0·268	0·260	0·253	0·245	0·237	0·230	37
38	0·304	0·296	0·288	0·280	0·272	0·265	0·257	0·250	0·242	0·235	0·227	0·220	38
39	0·291	0·284	0·276	0·269	0·261	0·254	0·246	0·239	0·231	0·224	0·217	0·210	39
40	0·279	0·272	0·264	0·257	0·250	0·242	0·235	0·228	0·221	0·214	0·207	0·199	40
41	0·267	0·260	0·252	0·245	0·238	0·231	0·224	0·217	0·210	0·203	0·196	0·188	41
42	0·255	0·247	0·240	0·233	0·227	0·220	0·213	0·206	0·199	0·192	0·186	0·178	42
43	0·242	0·235	0·228	0·222	0·215	0·208	0·202	0·195	0·188	0·182	0·175	0·168	43
44	0·230	0·223	0·216	0·210	0·203	0·197	0·190	0·184	0·177	0·171	0·164	0·158	44
45	0·217	0·211	0·204	0·198	0·192	0·185	0·179	0·173	0·166	0·160	0·154	0·147	45
46	0·205	0·198	0·192	0·186	0·180	0·174	0·167	0·161	0·155	0·149	0·143	0·136	46
47	0·192	0·186	0·180	0·174	0·168	0·162	0·156	0·150	0·144	0·138	0·132	0·126	47
48	0·179	0·173	0·168	0·162	0·156	0·150	0·144	0·138	0·132	0·127	0·121	0·115	48
49	0·167	0·161	0·155	0·149	0·144	0·138	0·132	0·126	0·121	0·115	0·109	0·104	49
50	0·154	0·148	0·142	0·137	0·131	0·126	0·120	0·115	0·109	0·104	0·098	0·093	50
51	0·140	0·135	0·130	0·124	0·119	0·113	0·108	0·103	0·097	0·092	0·086	0·081	51
52	0·127	0·122	0·117	0·111	0·106	0·101	0·096	0·090	0·085	0·080	0·075	0·069	52
53	0·114	0·108	0·103	0·098	0·093	0·088	0·083	0·078	0·073	0·068	0·063	0·058	53
54	0·100	0·095	0·090	0·085	0·080	0·075	0·070	0·065	0·060	0·055	0·051	0·046	54
55	0·086	0·081	0·076	0·072	0·067	0·062	0·057	0·052	0·048	0·043	0·038	0·033	55
56	0·072	0·067	0·063	0·058	0·053	0·049	0·044	0·039	0·035	0·030	0·025	0·021	56
57	0·057	0·053	0·048	0·044	0·039	0·035	0·030	0·026	0·021	0·017	0·012	0·008	57
58	0·043	0·038	0·034	0·030	0·025	0·021	0·017	0·013	0·008	0·003	9·999	9·995	58
59	0·028	0·023	0·019	0·015	0·011	0·007	0·002	9·998	9·994	9·990	9·985	9·981	59
60	0·012	0·008	0·004	0·000	9·996	9·992	9·988	9·984	9·980	9·976	9·971	9·967	60
61	9·996	9·992	9·989	9·985	9·981	9·977	9·973	9·969	9·965	9·961	9·957	9·953	61
62	9·980	9·976	9·973	9·909	9·965	9·961	9·957	9·954	9·950	9·946	9·942	9·938	62

LOGARITHMS
FOR COMPUTING THE REDUCTION TO THE MERIDIAN, AT SEA.
PART II. Latitude and Declination of *contrary* Names.

Lat.	Declination.												Lat.
	24°	25°	26°	27°	28°	29°	30°	31°	32°	33°	34°	35°	
0°	0·652	0·632	0·613	0·594	0·575	0·557	0·539	0·522	0·505	0·489	0·472	0·456	0°
1	0·636	0·617	0·598	0·579	0·561	0·544	0·526	0·510	0·493	0·477	0·461	0·445	1
2	0·620	0·601	0·583	0·565	0·548	0·531	0·514	0·498	0·482	0·466	0·450	0·435	2
3	0·605	0·587	0·569	0·551	0·535	0·518	0·502	0·486	0·470	0·455	0·439	0·424	3
4	0·589	0·572	0·555	0·538	0·522	0·506	0·490	0·474	0·459	0·444	0·429	0·414	4
5	0·574	0·558	0·541	0·525	0·509	0·494	0·478	0·463	0·448	0·433	0·419	0·404	5
6	0·560	0·544	0·528	0·512	0·497	0·482	0·467	0·452	0·437	0·423	0·409	0·395	6
7	0·546	0·531	0·515	0·500	0·485	0·470	0·456	0·441	0·427	0·413	0·399	0·385	7
8	0·533	0·518	0·503	0·488	0·473	0·459	0·445	0·431	0·417	0·404	0·390	0·376	8
9	0·520	0·506	0·491	0·476	0·462	0·448	0·434	0·421	0·407	0·394	0·380	0·367	9
10	0·507	0·493	0·479	0·465	0·451	0·437	0·424	0·411	0·397	0·384	0·371	0·358	10
11	0·495	0·481	0·467	0·453	0·440	0·426	0·413	0·401	0·387	0·375	0·362	0·349	11
12	0·483	0·469	0·455	0·442	0·429	0·416	0·403	0·391	0·378	0·366	0·353	0·341	12
13	0·471	0·457	0·444	0·431	0·418	0·406	0·393	0·381	0·368	0·356	0·344	0·332	13
14	0·459	0·446	0·433	0·421	0·408	0·396	0·384	0·372	0·359	0·347	0·335	0·323	14
15	0·448	0·435	0·422	0·410	0·398	0·386	0·374	0·362	0·349	0·338	0·326	0·315	15
16	0·436	0·424	0·412	0·400	0·388	0·376	0·364	0·353	0·341	0·330	0·318	0·307	16
17	0·425	0·413	0·402	0·390	0·378	0·366	0·355	0·344	0·332	0·321	0·309	0·298	17
18	0·414	0·403	0·391	0·380	0·368	0·357	0·346	0·335	0·323	0·312	0·301	0·290	18
19	0·404	0·392	0·381	0·370	0·358	0·347	0·336	0·326	0·314	0·303	0·292	0·282	19
20	0·393	0·382	0·371	0·360	0·349	0·338	0·327	0·317	0·306	0·295	0·284	0·274	20
21	0·383	0·371	0·361	0·350	0·339	0·329	0·318	0·308	0·297	0·286	0·276	0·266	21
22	0·372	0·361	0·351	0·340	0·330	0·320	0·309	0·299	0·288	0·278	0·268	0·258	22
23	0·362	0·351	0·341	0·330	0·320	0·310	0·300	0·289	0·279	0·270	0·260	0·250	23
24	0·351	0·341	0·331	0·321	0·311	0·301	0·291	0·281	0·271	0·262	0·252	0·242	24
25	0·341	0·331	0·321	0·311	0·301	0·292	0·282	0·272	0·262	0·253	0·243	0·234	25
26	0·331	0·322	0·312	0·302	0·292	0·283	0·273	0·264	0·254	0·245	0·235	0·226	26
27	0·321	0·312	0·302	0·292	0·283	0·274	0·264	0·256	0·246	0·237	0·227	0·218	27
28	0·311	0·302	0·292	0·283	0·274	0·265	0·256	0·248	0·238	0·229	0·219	0·210	28
29	0·301	0·292	0·282	0·274	0·265	0·256	0·247	0·239	0·229	0·221	0·211	0·202	29
30	0·291	0·282	0·273	0·265	0·256	0·247	0·238	0·230	0·221	0·213	0·204	0·195	30
31	0·281	0·272	0·263	0·255	0·246	0·238	0·229	0·221	0·212	0·204	0·196	0·187	31
32	0·271	0·263	0·254	0·246	0·237	0·229	0·221	0·213	0·204	0·196	0·187	0·179	32
33	0·261	0·253	0·245	0·237	0·228	0·220	0·212	0·204	0·195	0·187	0·179	0·171	33
34	0·252	0·244	0·236	0·228	0·220	0·212	0·203	0·195	0·187	0·179	0·171	0·163	34
35	0·242	0·234	0·226	0·218	0·210	0·203	0·194	0·186	0·178	0·170	0·162	0·155	35
36	0·232	0·225	0·217	0·209	0·201	0·194	0·186	0·178	0·170	0·162	0·154	0·147	36
37	0·222	0·215	0·207	0·199	0·191	0·184	0·176	0·169	0·161	0·153	0·145	0·138	37
38	0·212	0·205	0·197	0·190	0·182	0·175	0·167	0·160	0·152	0·145	0·137	0·130	38
39	0·202	0·195	0·187	0·180	0·173	0·166	0·158	0·152	0·143	0·136	0·129	0·122	39
40	0·192	0·185	0·178	0·171	0·164	0·157	0·150	0·143	0·135	0·128	0·121	0·114	40
41	0·182	0·175	0·168	0·162	0·155	0·148	0·141	0·134	0·127	0·120	0·113	0·106	41
42	0·172	0·165	0·158	0·152	0·145	0·138	0·131	0·125	0·118	0·111	0·104	0·097	42
43	0·161	0·155	0·148	0·142	0·135	0·129	0·122	0·116	0·109	0·102	0·095	0·088	43
44	0·151	0·144	0·138	0·132	0·126	0·119	0·113	0·106	0·100	0·093	0·086	0·079	44
45	0·141	0·134	0·128	0·122	0·116	0·110	0·103	0·097	0·090	0·084	0·077	0·071	45
46	0·131	0·124	0·118	0·112	0·106	0·100	0·094	0·087	0·081	0·074	0·068	0·062	46
47	0·120	0·114	0·108	0·102	0·096	0·090	0·084	0·078	0·071	0·065	0·058	0·053	47
48	0·109	0·103	0·098	0·092	0·086	0·080	0·074	0·068	0·062	0·056	0·049	0·043	48
49	0·098	0·092	0·087	0·082	0·075	0·070	0·064	0·058	0·052	0·046	0·040	0·034	49
50	0·087	0·081	0·076	0·071	0·064	0·059	0·054	0·048	0·042	0·036	0·030	0·024	50
51	0·076	0·070	0·064	0·060	0·054	0·049	0·043	0·037	0·032	0·026	0·020	0·014	51
52	0·064	0·059	0·053	0·048	0·043	0·038	0·032	0·027	0·021	0·016	0·010	0·004	52
53	0·052	0·048	0·042	0·037	0·031	0·027	0·021	0·016	0·010	0·005	0·000	9·994	53
54	0·040	0·036	0·031	0·026	0·020	0·015	0·010	0·005	9·999	9·994	9·989	9·984	54
55	0·028	0·024	0·019	0·014	0·009	0·003	9·998	9·994	9·988	9·983	9·978	9·973	55
56	0·016	0·011	0·006	0·002	9·997	9·992	9·987	9·982	9·977	9·972	9·967	9·962	56
57	0·003	9·999	9·994	9·990	9·985	9·980	9·975	9·970	9·965	9·961	9·955	9·951	57
58	9·990	9·986	9·981	9·977	9·973	9·968	9·963	9·958	9·953	9·949	9·944	9·939	58
59	9·977	9·973	9·968	9·964	9·960	9·956	9·950	9·946	9·941	9·937	9·932	9·927	59
60	9·963	9·959	9·955	9·951	9·946	9·943	9·937	9·933	9·928	9·924	9·920	9·915	60
61	9·948	9·945	9·941	9·937	9·932	9·929	9·924	9·920	9·915	9·911	9·907	9·902	61
62	9·934	9·930	9·926	9·923	9·918	9·914	9·910	9·906	9·902	9·898	9·894	9·889	62

LOGARITHMS

FOR COMPUTING THE CORRECTION OF THE LATITUDE BY ACCOUNT

PART I. Observations on the *same* side both of the Meridian and of the Prime Vertical.

AZIMUTHS.

	8°	10°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	32°	34°
12°	9·206													
14	9·316													
16	9·384	9·163												
18	9·430	9·238	9·035											
20	9·464	9·290	9·116	8·925										
22	9·490	9·329	9·172	9·010	8·829									
24	9·511	9·359	9·215	9·071	8·918	8·744								
26	9·528	9·383	9·248	9·116	8·981	8·836								
28	9·543	9·403	9·275	9·152	9·029	8·902	8·762							
30	9·555	9·419	9·297	9·182	9·068	8·953	8·831	8·695						
32	9·565	9·435	9·316	9·206	9·100	8·993	8·884	8·766						
34	9·575	9·446	9·332	9·227	9·126	9·027	8·926	8·821	8·707					
36	9·583	9·457	9·346	9·245	9·148	9·055	8·961	8·865	8·763	8·653				
38	9·590	9·467	9·359	9·260	9·168	9·079	8·991	8·901	8·809	8·711				
40	9·596	9·475	9·370	9·274	9·185	9·099	9·016	8·932	8·847	8·758	8·662			
42	9·602	9·483	9·379	9·286	9·200	9·118	9·038	8·959	8·879	8·797	8·710	8·617		
44	9·608	9·490	9·389	9·297	9·214	9·134	9·057	8·982	8·907	8·830	8·751	8·667	8·576	
46	9·613	9·497	9·397	9·308	9·226	9·149	9·075	9·003	8·931	8·859	8·785	8·708	8·626	8·537
48	9·617	9·503	9·404	9·317	9·237	9·162	9·090	9·021	8·953	8·885	8·815	8·744	8·668	8·589
50	9·622	9·508	9·411	9·325	9·247	9·174	9·105	9·038	8·972	8·907	8·842	8·775	8·705	8·632
52	9·626	9·513	9·418	9·333	9·256	9·185	9·118	9·053	8·990	8·927	8·865	8·802	8·737	8·670
54	9·629	9·518	9·424	9·340	9·265	9·195	9·129	9·067	9·006	8·946	8·886	8·826	8·765	8·702
56	9·633	9·523	9·429	9·347	9·273	9·205	9·141	9·079	9·020	8·962	8·905	8·848	8·790	8·731
58	9·636	9·527	9·435	9·354	9·281	9·214	9·151	9·091	9·034	8·978	8·923	8·868	8·813	8·757
60	9·639	9·531	9·440	9·360	9·288	9·222	9·160	9·102	9·046	8·992	8·939	8·886	8·834	8·781
62	9·642	9·535	9·444	9·365	9·295	9·230	9·169	9·112	9·058	9·005	8·954	8·903	8·853	8·802
64	9·645	9·539	9·449	9·371	9·301	9·237	9·178	9·122	9·069	9·018	8·968	8·919	8·870	8·822
66	9·648	9·542	9·453	9·376	9·307	9·244	9·186	9·131	9·079	9·029	8·981	8·933	8·887	8·840
68	9·651	9·545	9·457	9·381	9·313	9·251	9·194	9·140	9·089	9·040	8·993	8·947	8·902	8·857
70	9·653	9·549	9·461	9·386	9·319	9·258	9·201	9·148	9·099	9·051	9·005	8·960	8·916	8·873
72	9·656	9·552	9·465	9·390	9·324	9·264	9·208	9·156	9·107	9·061	9·016	8·972	8·930	8·887
74	9·658	9·555	9·469	9·395	9·329	9·270	9·215	9·164	9·116	9·070	9·026	8·984	8·942	8·902
76	9·661	9·558	9·473	9·399	9·334	9·275	9·222	9·171	9·124	9·079	9·036	8·995	8·959	8·915
78	9·663	9·561	9·476	9·403	9·339	9·281	9·228	9·178	9·132	9·088	9·046	9·006	8·966	8·928
80	9·665	9·564	9·480	9·408	9·344	9·287	9·234	9·185	9·140	9·097	9·055	9·016	8·977	8·940
82	9·667	9·567	9·483	9·412	9·349	9·292	9·240	9·192	9·147	9·105	9·065	9·026	8·988	8·952
84	9·670	9·569	9·487	9·416	9·353	9·297	9·246	9·199	9·155	9·113	9·073	9·035	8·999	8·963
86	9·672	9·572	9·490	9·420	9·358	9·302	9·252	9·205	9·162	9·121	9·082	9·045	9·009	8·974
88	9·674	9·575	9·493	9·423	9·362	9·307	9·257	9·211	9·169	9·128	9·090	9·054	9·019	8·985
90	9·676	9·578	9·496	9·427	9·366	9·312	9·263	9·218	9·175	9·136	9·098	9·062	9·028	8·995
	36°	38°	40°	42°	44	46°	48°	50°	52°	54°	56°	58°	60°	62°
54	8·637	8·567	8·492	8·408	8·314									
56	8·670	8·606	8·538	8·464	8·381	8·288								
58	8·700	8·640	8·577	8·510	8·437	8·356	8·264							
60	8·726	8·671	8·612	8·551	8·485	8·413	8·333	8·242						
62	8·750	8·698	8·643	8·587	8·526	8·461	8·391	8·312	8·221					
64	8·773	8·723	8·671	8·618	8·563	8·503	8·440	8·370	8·292					
66	8·793	8·745	8·697	8·647	8·595	8·540	8·482	8·419	8·350	8·273				
68	8·812	8·766	8·720	8·673	8·624	8·573	8·520	8·462	8·401	8·332	8·256			
70	8·829	8·786	8·742	8·697	8·651	8·603	8·553	8·501	8·444	8·383	8·316	8·240		
72	8·846	8·804	8·762	8·719	8·676	8·631	8·584	8·535	8·483	8·428	8·367	8·301	8·226	
74	8·861	8·821	8·781	8·740	8·698	8·656	8·612	8·566	8·518	8·467	8·412	8·353	8·287	
76	8·876	8·837	8·798	8·759	8·719	8·679	8·638	8·595	8·550	8·503	8·453	8·398	8·346	8·275
78	8·890	8·852	8·815	8·777	8·739	8·701	8·661	8·621	8·579	8·535	8·489	8·439	8·386	8·328
80	8·903	8·867	8·831	8·794	8·758	8·721	8·684	8·645	8·606	8·564	8·521	8·476	8·427	8·375
82	8·916	8·881	8·846	8·811	8·776	8·740	8·705	8·668	8·631	8·591	8·551	8·509	8·464	8·416
84	8·928	8·894	8·860	8·826	8·793	8·759	8·724	8·690	8·654	8·617	8·579	8·540	8·498	8·454
86	8·940	8·907	8·874	8·841	8·809	8·776	8·743	8·710	8·676	8·641	8·605	8·568	8·529	8·488
88	8·951	8·919	8·887	8·856	8·824	8·793	8·761	8·729	8·697	8·664	8·630	8·595	8·558	8·520
90	8·963	8·931	8·900	8·869	8·839	8·809	8·778	8·748	8·717	8·685	8·653	8·620	8·585	8·550

LOGARITHMS
FOR COMPUTING THE CORRECTION OF THE LATITUDE BY ACCOUNT.

PART II. Observations on *different* sides either of the Meridian or of the Prime Vertical.

AZIMUTHS.

	8°	10°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	32°	34°
8°	9·977													
10	9·931	9·879												
12	9·897	9·840	9·797											
14	9·870	9·810	9·764	9·728										
16	9·849	9·786	9·737	9·699	9·667									
18	9·832	9·766	9·715	9·674	9·641	9·613								
20	9·818	9·749	9·696	9·654	9·619	9·589	9·564							
22	9·806	9·735	9·680	9·636	9·599	9·568	9·542	9·519						
24	9·795	9·722	9·666	9·620	9·582	9·550	9·522	9·498	9·476					
26	9·786	9·712	9·654	9·606	9·567	9·534	9·505	9·480	9·457	9·437				
28	9·778	9·702	9·643	9·594	9·554	9·519	9·489	9·463	9·440	9·418	9·399			
30	9·771	9·693	9·633	9·583	9·542	9·506	9·475	9·448	9·424	9·402	9·382	9·364		
32	9·764	9·686	9·624	9·573	9·530	9·494	9·462	9·434	9·409	9·386	9·366	9·347	9·329	
34	9·758	9·678	9·616	9·564	9·520	9·483	9·450	9·421	9·395	9·372	9·351	9·331	9·313	9·296
36	9·753	9·672	9·608	9·555	9·511	9·473	9·439	9·410	9·383	9·359	9·337	9·316	9·298	9·280
38	9·748	9·666	9·601	9·547	9·502	9·463	9·429	9·399	9·371	9·346	9·324	9·303	9·283	9·265
40	9·743	9·660	9·594	9·540	9·494	9·454	9·419	9·388	9·360	9·335	9·311	9·290	9·270	9·251
42	9·739	9·655	9·588	9·533	9·486	9·446	9·410	9·378	9·350	9·324	9·300	9·278	9·257	9·238
44	9·735	9·650	9·583	9·527	9·479	9·438	9·402	9·369	9·340	9·313	9·289	9·266	9·245	9·225
46	9·731	9·646	9·578	9·521	9·473	9·431	9·394	9·361	9·331	9·303	9·278	9·255	9·233	9·213
48	9·728	9·642	9·573	9·515	9·466	9·424	9·386	9·352	9·322	9·294	9·268	9·244	9·222	9·201
50	9·725	9·638	9·568	9·510	9·460	9·417	9·379	9·344	9·313	9·285	9·258	9·234	9·211	9·19[illegible]
52	9·721	9·634	9·563	9·504	9·454	9·410	9·372	9·337	9·305	9·276	9·249	9·224	9·201	9·179
54	9·718	9·630	9·559	9·499	9·449	9·404	9·365	9·329	9·297	9·267	9·240	9·215	9·191	9·168
56	9·715	9·626	9·555	9·495	9·443	9·398	9·358	9·322	9·289	9·259	9·231	9·205	9·181	9·158
58	9·713	9·623	9·551	9·490	9·438	9·392	9·352	9·315	9·282	9·251	9·223	9·196	9·171	9·148
60	9·710	9·620	9·547	9·486	9·433	9·387	9·346	9·309	9·275	9·243	9·215	9·187	9·162	9·138
62	9·707	9·617	9·543	9·481	9·428	9·381	9·340	9·302	9·268	9·236	9·206	9·179	9·153	9·128
64	9·705	9·613	9·539	9·477	9·423	9·376	9·334	9·296	9·261	9·228	9·198	9·170	9·144	9·118
66	9·702	9·610	9·536	9·473	9·419	9·371	9·328	9·289	9·254	9·221	9·191	9·162	9·135	9·109
68	9·700	9·607	9·532	9·469	9·414	9·366	9·322	9·283	9·247	9·214	9·183	9·154	9·126	9·100
70	9·698	9·605	9·529	9·465	9·410	9·361	9·317	9·277	9·241	9·207	9·175	9·145	9·117	9·090
72	9·695	9·602	9·525	9·461	9·405	9·356	9·311	9·271	9·234	9·200	9·167	9·137	9·108	9·081
74	9·693	9·599	9·522	9·457	9·401	9·351	9·306	9·265	9·228	9·193	9·160	9·129	9·100	9·072
76	9·691	9·596	9·519	9·453	9·396	9·346	9·301	9·259	9·221	9·186	9·152	9·121	9·091	9·062
78	9·689	9·594	9·516	9·450	9·392	9·341	9·295	9·253	9·215	9·179	9·145	9·113	9·082	9·053
80	9·687	9·591	9·512	9·446	9·388	9·336	9·290	9·247	9·208	9·172	9·137	9·105	9·074	9·044
82	9·685	9·588	9·509	9·442	9·384	9·332	9·285	9·241	9·202	9·165	9·130	9·096	9·065	9·034
84	9·682	9·586	9·506	9·438	9·379	9·327	9·279	9·236	9·195	9·157	9·122	9·088	9·056	9·025
86	9·680	9·583	9·503	9·435	9·375	9·322	9·274	9·230	9·189	9·150	9·114	9·080	9·047	9·015
88	9·678	9·580	9·500	9·431	9·371	9·317	9·268	9·224	9·182	9·143	9·106	9·071	9·037	9·005
90	9·676	9·578	9·496	9·427	9·366	9·312	9·263	9·218	9·175	9·136	9·098	9·062	9·028	8·995

	36°	38°	40°	42°	44°	46°	48°	50°	52°	54°	56°	58°	60°	62°
36°	9·264													
38	9·248	9·232												
40	9·234	9·217	9·201											
42	9·220	9·202	9·186	9·171										
44	9·206	9·189	9·172	9·156	9·140									
46	9·193	9·175	9·158	9·141	9·125	9·110								
48	9·181	9·162	9·145	9·127	9·111	9·095	9·079							
50	9·169	9·150	9·132	9·114	9·097	9·080	9·064	9·049						
52	9·158	9·138	9·119	9·101	9·083	9·066	9·050	9·034	9·018					
54	9·147	9·126	9·107	9·088	9·070	9·052	9·035	9·019	9·002	8·986				
56	9·136	9·115	9·095	9·076	9·057	9·039	9·021	9·004	8·987	8·970	8·954			
58	9·125	9·104	9·083	9·063	9·044	9·025	9·007	8·989	8·972	8·955	8·938	8·921		
60	9·115	9·093	9·072	9·051	9·032	9·012	8·994	8·975	8·957	8·939	8·921	8·904	8·886	
62	9·105	9·083	9·060	9·039	9·019	8·999	8·980	8·961	8·942	8·924	8·905	8·887	8·869	8·851
64	9·094	9·071	9·049	9·028	9·007	8·986	8·966	8·947	8·927	8·908	8·889	8·870	8·851	8·832
66	9·084	9·061	9·038	9·016	8·994	8·973	8·953	8·933	8·913	8·893	8·873	8·853	8·834	8·814
68	9·074	9·050	9·027	9·004	8·982	8·960	8·939	8·918	8·898	8·877	8·857	8·836	8·816	8·795

LOGARITHMS
FOR COMPUTING THE CORRECTION OF THE LATITUDE BY ACCOUNT

PART II. (continued.) Observations on *different* sides either of the Meridian or of the Prime Vertical.

AZIMUTHS.

	36°	38°	40°	42°	44°	46°	48°	50°	52°	54°	56°	58°	60°	62°
70°	9·065	9·040	9·016	8·993	8·970	8·948	8·926	8·904	8·883	8·862	8·848	8·819	8·798	8·776
72	9·055	9·029	9·005	8·981	8·958	8·935	8·912	8·890	8·868	8·846	8·824	8·802	8·779	8·757
74	9·045	9·019	8·994	8·969	8·945	8·922	8·898	8·875	8·853	8·830	8·807	8·784	8·760	8·737
76	9·035	9·008	8·983	8·957	8·933	8·909	8·885	8·861	8·837	8·813	8·790	8·766	8·741	8·717
78	9·025	8·998	8·971	8·946	8·920	8·895	8·870	8·846	8·821	8·797	8·772	8·747	8·721	8·696
80	9·015	8·987	8·960	8·933	8·907	8·882	8·856	8·831	8·805	8·780	8·754	8·728	8·701	8·674
82	9·005	8·976	8·948	8·921	8·894	8·868	8·841	8·815	8·789	8·762	8·725	8·708	8·680	8·651
84	8·995	8·965	8·937	8·909	8·881	8·854	8·826	8·799	8·772	8·744	8·716	8·687	8·658	8·628
86	8·984	8·954	8·925	8·896	8·867	8·839	8·811	8·782	8·754	8·725	8·696	8·666	8·635	8·603
88	8·974	8·943	8·913	8·883	8·853	8·824	8·795	8·765	8·736	8·706	8·675	8·643	8·611	8·577
90	8·963	8·931	8·900	8·869	8·839	8·809	8·778	8·748	8·717	8·685	8·653	8·620	8·585	8·550

TABLE 72

LOGARITHMS
FOR COMPUTING THE EQUATION OF EQUAL ALTITUDES

Interval.	Log. A.	Log. B	Interval	Log. A.	Log. B.	Interval	Log. A.	Log. B
1h 30m	2·2725	2·2809	4h 30m	2·2499	2·3300	7h 30m	2·2032	2·4584
1 35	2·2722	2·2816	4 35	2·2489	2·3323	7 35	2·2015	2·4645
1 40	2·2719	2·2823	4 40	2·2479	2·3346	7 40	2·1998	2·4699
1 45	2·2715	2·2831	4 45	2·2469	2·3370	7 45	2·1980	2·4755
1 50	2·2711	2·2838	4 50	2·2459	2·3394	7 50	2·1963	2·4814
1 55	2·2707	2·2846	4 55	2·2449	2·3418	7 55	2·1945	2·4876
2 0	2·2703	2·2854	5 0	2·2438	2·3444	8 0	2·1928	2·4938
2 5	2·2699	2·2863	5 5	2·2428	2·3470	8 5	2·1910	2·5004
2 10	2·2695	2·2872	5 10	2·2417	2·3497	8 10	2·1892	2·5070
2 15	2·2690	2·2882	5 15	2·2406	2·3524	8 15	2·1874	2·5141
2 20	2·2685	2·2891	5 20	2·2394	2·3552	8 20	2·1855	2·5211
2 25	2·2680	2·2902	5 25	2·2383	2·3581	8 25	2·1836	2·5286
2 30	2·2675	2·2912	5 30	2·2371	2·3610	8 30	2·1817	2·5360
2 35	2·2669	2·2924	5 35	2·2359	2·3641	8 35	2·1798	2·5439
2 40	2·2664	2·2935	5 40	2·2347	2·3671	8 40	2·1778	2·5518
2 45	2·2658	2·2947	5 45	2·2334	2·3703	8 45	2·1758	2·5602
2 50	2·2652	2·2959	5 50	2·2322	2·3735	8 50	2·1738	2·5688
2 55	2·2646	2·2972	5 55	2·2309	2·3768	8 55	2·1718	2·5776
3 0	2·2641	2·2985	6 0	2·2297	2·3802	9 0	2·1697	2·5868
3 5	2·2634	2·2998	6 5	2·2283	2·3837	9 5	2·1677	2·5963
3 10	2·2628	2·3012	6 10	2·2271	2·3873	9 10	2·1656	2·6063
3 15	2·2621	2·3027	6 15	2·2257	2·3910	9 15	2·1635	2·6164
3 20	2·2614	2·3042	6 20	2·2241	2·3947	9 20	2·1613	2·6273
3 25	2·2607	2·3058	6 25	2·2230	2·3986	9 25	2·1592	2·6384
3 30	2·2600	2·3073	6 30	2·2216	2·4024	9 30	2·1570	2·6499
3 35	2·2592	2·3090	6 35	2·2202	2·4065	9 35	2·1547	2·6619
3 40	2·2585	2·3106	6 40	2·2187	2·4106	9 40	2·1525	2·6744
3 45	2·2577	2·3124	6 45	2·2173	2·4149	9 45	2·1502	2·6874
3 50	2·2569	2·3141	6 50	2·2158	2·4192	9 50	2·1480	2·7011
3 55	2·2561	2·3159	6 55	2·2143	2·4237	9 55	2·1457	2·7154
4 0	2·2553	2·3177	7 0	2·2127	2·4283	10 0	2·1433	2·7303
4 5	2·2544	2·3196	7 5	2·2112	2·4330	10 5	2·1409	2·7460
4 10	2·2536	2·3216	7 10	2·2096	2·4378	10 10	2·1386	2·7626
4 15	2·2527	2·3236	7 15	2·2080	2·4426	10 15	2·1361	2·7801
4 20	2·2518	2·3257	7 20	2·2064	2·4478	10 20	2·1337	2·7984
4 25	2·2509	2·3278	7 25	2·2048	2·4531	10 25	2·1312	2·8176

THE LOGARITHMIC DIFFERENCE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°.)

☽ App. Alt.	Horizontal Parallax. 53′	54′	55′	56′	57′	58′	59′	60′	61′	″ of Par.	Corr. for ″ of Par. 0″	2″	4″	6″	8″	10″	Cor. for ′ of Alt.
	9·99	9·99	9·99	9·99	9·99	9·99	9·99	9·99	9·99								
3° 0	9841	9833	9825	9817	9809	9800	9792	9784	9776	0	0	0	0	1	2	2	
10	9822	9814	9806	9797	9789	9780	9771	9763	9754	10	2	2	2	3	3	3	
20	9804	9795	9786	9777	9769	9760	9751	9742	9732	20	3	3	4	4	5	5	
30	9785	9776	9767	9758	9748	9739	9730	9720	9711	30	5	5	5	6	6	6	
40	9767	9757	9747	9738	9728	9718	9709	9699	9689	40	6	7	7	8	8	8	
50	9748	9738	9728	9718	9708	9698	9687	9677	9667	50	8	8	9	9	10	11	sub.
4 0	9729	9718	9708	9698	9687	9677	9666	9656	9645	0	0	0	0	1	2	2	H.P.
10	9710	9699	9689	9678	9667	9656	9645	9634	9623	10	2	2	2	3	4	4	53
20	9691	9680	9669	9658	9646	9635	9624	9613	9601	20	4	4	5	5	6	6	
30	9672	9660	9649	9637	9626	9614	9603	9591	9579	30	6	6	7	7	8	8	1′ 2
40	9653	9641	9629	9617	9605	9593	9581	9569	9557	40	8	8	9	9	10	10	2 4
50	9634	9622	9609	9597	9585	9572	9560	9547	9535	50	10	10	11	11	12	12	3 6
5 0	9614	9602	9589	9576	9563	9551	9538	9525	9512	0	0	0	1	1	2	2	4 8
10	9595	9582	9569	9556	9543	9530	9516	9503	9490	10	2	3	3	3	4	4	5 9
20	9576	9562	9549	9535	9522	9509	9495	9481	9468	20	4	5	5	6	6	7	6 11
30	9557	9543	9529	9515	9501	9487	9474	9460	9446	30	7	7	8	8	9	9	7 13
40	9538	9523	9509	9495	9481	9466	9452	9438	9424	40	9	10	10	11	11	12	8 15
50	9518	9504	9489	9474	9460	9445	9431	9416	9401	50	12	13	13	14	14	14	9 17
6 0	9499	9484	9469	9454	9439	9424	9409	9394	9379	0	0	0	1	1	2	3	
10	9480	9465	9449	9434	9418	9403	9388	9372	9357	10	3	3	4	4	5	5	
20	9461	9445	9429	9413	9398	9382	9366	9350	9334	20	5	6	6	7	7	8	
30	9441	9425	9409	9393	9377	9361	9345	9329	9312	30	8	8	9	10	10	11	
40	9422	9406	9389	9373	9356	9340	9323	9307	9290	40	11	11	12	13	13	1	
50	9403	9386	9369	9352	9335	9319	9301	9285	9268	50	14	15	15	16	16	16	
7 0	9383	9366	9349	9332	9314	9297	9280	9263	9246	0	0	1	1	2	2	3	
10	9364	9347	9329	9311	9294	9276	9258	9241	9223	10	3	3	4	5	5	6	
20	9345	9327	9309	9291	9273	9255	9237	9219	9201	20	6	7	7	8	8	9	
30	9326	9307	9289	9271	9252	9234	9216	9197	9179	30	9	10	10	11	12	12	
40	9306	9288	9269	9250	9232	9213	9194	9175	9157	40	12	13	14	14	15	16	H.P
50	9287	9268	9249	9230	9211	9192	9173	9154	9134	50	16	16	17	18	18	19	61′
8 0	9268	9248	9229	9209	9190	9170	9151	9132	9112	0	0	1	1	2	3	3	
10	9249	9229	9209	9189	9169	9149	9130	9110	9090	10	3	4	5	5	6	7	1′ 2
20	9229	9209	9189	9169	9149	9128	9108	9088	9068	20	7	7	8	9	9	10	2 4
30	9210	9189	9169	9148	9128	9107	9087	9066	9046	30	10	11	12	12	13	14	3 7
40	9191	9170	9149	9128	9107	9086	9065	9044	9023	40	14	15	15	16	17	18	4 9
50	9172	9150	9129	9108	9086	9065	9044	9022	9001	50	18	19	19	20	21	21	5 11
9 0	9152	9131	9109	9087	9066	9044	9022	9001	8979	0	0	1	1	2	3	4	6 13
10	9133	9111	9089	9067	9045	9023	9001	8979	8957	10	4	4	5	6	7	7	7 15
20	9114	9091	9069	9047	9024	9002	8979	8957	8935	20	7	8	9	10	10	11	8 18
30	9095	9072	9049	9026	9004	8981	8958	8935	8912	30	11	12	13	14	14	15	9 20
40	9075	9052	9029	9006	8983	8960	8937	8913	8890	40	15	16	17	18	18	20	
50	9056	9032	9009	8986	8962	8939	8915	8892	8868	50	20	20	21	22	23	23	

Sun's Alt. 5° 6° 7 8° 14° 25° 34 42° 51° 64° 90°
Sub 17 13 11 9 7 9 11 13 15 17 18

Star's Alt. 5° 6° 7° 8° 9° 11° 12° 14° 18° 30
Sub. 15 11 9 7 5 4 3 2 1 0

The Logarithmic Difference is not given in this Table for altitudes less than 3°, because the lunar observation ought not to be employed with very low altitudes.

THE LOGARITHMIC DIFFERENCE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°.)

☽ App. Alt	Horizontal Parallax. 53′	54′	55′	56′	57′	58′	59′	60′	61′	″ of Par.	Corr. for ″ of Par. *sub.* 0″	2	4	6	8	10	Cor. for ″ of Alt.
	9·99	9·99	9·99	9·99	9·99	9·99	9·99	9·99	9·99								
10° 0	9037	9013	8989	8965	8941	8917	8894	8870	8846	0	0	1	2	2	3	4	
10	9018	8993	8969	8945	8921	8896	8872	8848	8824	10	4	5	6	6	7	8	
20	8998	8974	8949	8925	8900	8875	8851	8826	8802	20	8	9	10	11	11	12	
30	8979	8954	8929	8904	8879	8854	8830	8805	8780	30	12	13	14	15	16	17	
40	8960	8935	8909	8884	8859	8833	8808	8783	8758	40	17	18	18	19	20	21	
50	8941	8915	8889	8864	8838	8812	8787	8761	8735	50	21	22	23	24	25	26	*sub.*
11 0	8922	8896	8869	8843	8817	8791	8765	8739	8713	0	0	1	2	3	3	4	
10	8903	8876	8850	8823	8797	8771	8744	8718	8691	10	4	5	6	7	8	9	
20	8883	8857	8830	8803	8776	8750	8723	8696	8669	20	9	10	11	12	13	13	
30	8864	8837	8810	8783	8756	8729	8702	8675	8647	30	13	14	15	16	17	18	H.P.
40	8845	8818	8790	8763	8735	8708	8680	8653	8625	40	18	19	20	21	22	23	53′
50	8826	8799	8771	8743	8715	8687	8659	8631	8604	50	23	24	25	26	27	28	
12 0	8807	8779	8751	8723	8694	8666	8638	8610	8582	0	0	1	2	3	4	5	1 2
10	8788	8760	8731	8703	8674	8645	8617	8588	8560	10	5	6	7	8	8	10	2 4
20	8769	8740	8711	8682	8653	8624	8595	8566	8538	20	10	11	12	12	13	15	3 6
30	8750	8721	8691	8662	8633	8603	8574	8545	8516	30	15	16	17	17	18	20	4 8
40	8731	8701	8672	8642	8612	8582	8553	8523	8494	40	20	21	22	23	24	25	5 9
50	8712	8682	8652	8622	8592	8562	8532	8502	8472	50	25	26	27	28	29	29	6 11
13 0	8693	8662	8632	8601	8571	8541	8510	8480	8450	0	0	1	2	3	4	5	7 13
10	8674	8643	8612	8581	8551	8520	8489	8458	8428	10	5	6	7	8	9	10	8 15
20	8655	8624	8592	8561	8530	8499	8468	8437	8406	20	10	11	12	13	14	16	9 17
30	8636	8604	8573	8541	8510	8478	8447	8416	8384	30	16	17	18	19	20	21	
40	8617	8585	8553	8521	8490	8458	8426	8394	8362	40	21	22	23	24	25	27	
50	8598	8566	8533	8501	8469	8437	8405	8373	8340	50	27	28	29	30	31	32	
14 0	8579	8546	8514	8481	8449	8416	8384	8351	8318	0	0	1	2	3	4	5	
10	8560	8527	8494	8461	8428	8395	8363	8330	8297	10	5	7	8	9	10	11	
20	8541	8508	8474	8441	8408	8375	8341	8308	8275	20	11	12	13	14	15	17	
30	8522	8489	8455	8421	8388	8354	8320	8287	8253	30	17	18	19	20	21	23	
40	8503	8469	8435	8401	8367	8333	8299	8266	8232	40	23	24	25	26	27	28	
50	8484	8450	8416	8381	8347	8313	8278	8244	8210	50	28	30	31	32	33	34	
15 0	8465	8431	8396	8361	8327	8292	8257	8223	8188	0	0	1	2	3	5	6	
10	8447	8412	8377	8342	8307	8271	8236	8201	8166	10	6	7	8	9	10	12	
20	8428	8392	8357	8322	8286	8251	8215	8180	8145	20	12	13	14	15	16	18	
30	8409	8373	8338	8302	8266	8230	8195	8159	8123	30	18	19	20	22	23	24	
40	8390	8354	8318	8282	8246	8210	8174	8138	8101	40	24	25	26	28	29	30	
50	8371	8335	8299	8262	8226	8189	8153	8116	8080	50	30	31	33	34	35	36	
16 0	8353	8316	8279	8242	8205	8169	8132	8095	8058	0	0	1	2	4	5	6	
10	8334	8297	8260	8222	8185	8148	8111	8074	8037	10	6	7	9	10	11	12	
20	8315	8278	8240	8203	8165	8128	8090	8053	8015	20	12	14	15	16	17	19	
30	8297	8259	8221	8183	8145	8107	8069	8031	7994	30	19	20	21	23	24	24	
40	8278	8240	8201	8163	8125	8087	8048	8010	7972	40	25	27	28	29	31	32	
50	8259	8221	8182	8143	8105	8066	8028	7989	7950	50	32	33	35	36	37	38	
17 0	8240	8201	8162	8124	8085	8046	8007	7968	7929	0	0	1	3	4	5	7	H.P.
10	8222	8183	8143	8104	8065	8025	7986	7947	7907	10	7	8	9	10	12	13	61′
20	8203	8164	8124	8084	8045	8005	7965	7926	7886	20	13	14	16	17	18	20	
30	8185	8145	8105	8065	8025	7985	7945	7905	7865	30	20	21	23	24	25	27	1 2
40	8166	8126	8085	8045	8005	7964	7924	7884	7843	40	27	28	30	34	32	34	2 4
50	8147	8107	8066	8025	7985	7944	7903	7863	7822	50	34	35	37	38	39	40	3 7
18 0	8129	8088	8047	8006	7965	7924	7882	7841	7800	0	0	1	3	4	5	7	4 9
10	8110	8069	8027	7986	7945	7903	7862	7820	7779	10	7	8	10	11	12	14	5 11
20	8092	8050	8008	7967	7925	7883	7841	7800	7758	20	14	15	17	18	19	21	6 13
30	8073	8031	7989	7947	7905	7863	7821	7779	7736	30	21	22	24	25	27	28	7 15
40	8055	8012	7970	7927	7885	7842	7800	7758	7715	40	28	30	31	32	34	36	8 18
50	8036	7993	7950	7908	7865	7822	7779	7737	7694	50	36	37	39	40	41	42	9 20
19 0	8018	7974	7931	7888	7845	7802	7759	7715	7672	0	0	1	3	4	6	7	
10	7999	7956	7912	7869	7825	7782	7738	7695	7651	10	7	9	10	12	13	15	
20	7981	7937	7893	7849	7805	7762	7718	7674	7630	20	15	16	17	19	20	22	
30	7962	7918	7874	7830	7786	7741	7697	7653	7609	30	22	24	25	27	28	30	
40	7944	7899	7855	7811	7766	7721	7677	7632	7588	40	30	31	33	34	36	37	
50	7926	7881	7836	7791	7746	7701	7656	7611	7567	50	37	39	40	42	43	44	

Sun's Alt.	5	6°	7	8	11	25°	34	42	51	64	90
sub.	17	13	11	9	7	9	11	13	15	17	18

Star's Alt.	5	6	7°	8°	9°	11	12°	14	18	30
sub.	15	11	9	7	5	4	3	2	1	0

THE LOGARITHMIC DIFFERENCE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°)

☽ App. Alt.	Horizontal Parallax. 53′	54′	55′	56′	57′	58′	59′	60′	61′	″ of Par.	Corr. for ″ of Par. sub 0″	2″	4″	6″	8″	10	Cor. for ″ of Alt.
	9·99	9·99	9·99	9·99	9·99	9·99	9·99	9·99	9·99								
20° 0′	7907	7862	7817	7772	7726	7681	7636	7591	7545	0	0	1	3	4	6	8	
10	7889	7843	7798	7752	7707	7661	7615	7570	7524	10	8	9	11	12	14	15	
20	7871	7825	7779	7733	7687	7641	7595	7549	7503	20	15	17	18	20	21	23	sub.
30	7852	7806	7760	7714	7667	7621	7575	7529	7482	30	23	25	26	28	29	34	
40	7834	7788	7741	7694	7648	7601	7554	7508	7461	40	31	33	34	36	37	39	
50	7816	7769	7722	7674	7628	7581	7534	7487	7440	50	39	41	42	44	45	46	
21 0	7798	7750	7703	7656	7608	7561	7514	7466	7419	0	0	2	3	5	6	8	
10	7779	7732	7684	7636	7589	7541	7493	7446	7398	10	8	9	11	12	14	16	H.P.
20	7761	7713	7665	7617	7569	7521	7473	7425	7377	20	16	18	19	21	22	24	53′
30	7743	7695	7646	7598	7550	7501	7453	7405	7356	30	24	26	27	29	30	32	
40	7725	7676	7628	7579	7530	7481	7433	7384	7336	40	32	34	36	37	39	41	
50	7707	7658	7609	7560	7511	7462	7413	7364	7315	50	41	42	44	46	47	48	1′ 2
22 0	7689	7639	7590	7540	7491	7442	7392	7343	7294	0	0	2	3	5	7	8	2 4
10	7671	7621	7571	7521	7472	7422	7372	7323	7273	10	8	10	12	13	15	17	3 5
20	7653	7602	7552	7502	7452	7402	7352	7302	7252	20	17	18	20	22	23	25	4 7
30	7635	7584	7534	7483	7433	7383	7332	7282	7232	30	25	27	28	30	32	34	5 9
40	7617	7566	7515	7464	7414	7363	7312	7261	7211	40	34	35	37	39	40	42	6 11
50	7598	7547	7496	7445	7394	7343	7292	7241	7190	50	42	42	45	48	49	50	7 13
23 0	7581	7529	7478	7426	7375	7323	7272	7221	7169	0	0	2	3	5	7	9	8 14
10	7563	7511	7459	7407	7356	7304	7252	7200	7149	10	9	10	12	14	15	17	9 16
20	7545	7493	7441	7389	7336	7284	7232	7180	7128	20	17	19	21	23	24	26	
30	7527	7474	7422	7370	7317	7265	7212	7160	7107	30	26	28	30	31	33	35	
40	7509	7456	7403	7351	7298	7245	7192	7140	7087	40	35	37	39	40	42	44	
50	7491	7438	7385	7332	7279	7226	7173	7119	7066	50	44	46	48	50	51	53	
24 0	7473	7420	7366	7313	7259	7206	7153	7099	7046	0	0	2	4	5	7	9	
10	7455	7402	7348	7294	7240	7187	7133	7079	7025	10	9	11	13	14	16	18	
20	7438	7384	7330	7275	7221	7167	7113	7059	7005	20	18	20	22	23	25	27	
30	7420	7365	7311	7257	7202	7148	7093	7039	6984	30	27	29	31	33	34	36	
40	7402	7347	7293	7238	7183	7128	7074	7019	6964	40	36	38	40	42	44	46	
50	7384	7329	7274	7219	7164	7109	7054	6999	6944	50	46	48	49	51	53	55	
25 0	7367	7311	7256	7200	7145	7090	7034	6979	6923	0	0	2	4	5	7	9	
10	7349	7293	7238	7182	7126	7070	7014	6959	6903	10	9	11	13	15	17	19	
20	7331	7275	7219	7163	7107	7051	6995	6939	6883	20	19	20	22	24	26	28	
30	7314	7258	7201	7145	7088	7032	6975	6919	6862	30	28	30	32	34	36	38	
40	7296	7240	7183	7126	7069	7012	6956	6899	6842	40	38	40	42	44	45	48	
50	7279	7222	7165	7107	7050	6993	6936	6879	6822	50	48	49	51	53	55	57	
26 0	7261	7204	7146	7089	7031	6974	6916	6859	6802	0	0	2	4	6	8	9	
10	7244	7186	7128	7070	7013	6955	6897	6839	6781	10	9	12	14	15	17	19	
20	7226	7168	7110	7052	6994	6936	6878	6820	6761	20	19	21	23	25	27	29	
30	7209	7150	7092	7034	6975	6917	6858	6800	6741	30	29	31	33	35	37	39	H.P.
40	7191	7133	7074	7015	6956	6898	6839	6780	6721	40	39	41	43	45	47	49	
50	7174	7115	7056	6997	6938	6878	6819	6760	6701	50	49	51	53	55	57	59	60′
27 0	7156	7097	7038	6978	6919	6859	6800	6740	6681	0	0	2	4	6	8	10	
10	7139	7079	7020	6960	6900	6840	6781	6721	6661	10	10	12	14	16	18	20	1′ 2
20	7122	7062	7002	6942	6882	6822	6761	6701	6641	20	20	22	24	26	28	30	2 4
30	7105	7044	6984	6923	6863	6803	6742	6682	6621	30	30	32	34	36	38	40	3 6
40	7087	7027	6966	6905	6844	6784	6723	6662	6602	40	40	42	44	46	48	50	4 8
50	7070	7009	6948	6887	6826	6765	6704	6643	6582	50	51	53	55	57	59	60	5 10
28 0	7053	6991	6930	6869	6807	6746	6684	6623	6562	0	0	2	4	6	8	10	6 13
10	7036	6974	6912	6851	6789	6727	6665	6604	6542	10	10	12	14	16	18	21	7 15
20	7018	6956	6894	6832	6770	6708	6646	6584	6522	20	21	23	25	27	29	31	8 17
30	7001	6939	6877	6814	6752	6690	6627	6565	6503	30	31	33	35	37	39	42	9 19
40	6984	6922	6859	6796	6734	6671	6608	6545	6483	40	42	44	46	48	50	52	
50	6967	6904	6841	6778	6715	6651	6589	6526	6463	50	52	55	57	59	61	63	
29 0	6950	6887	6823	6760	6697	6633	6570	6507	6443	0	0	2	4	6	8	11	
10	6933	6869	6806	6742	6678	6615	6551	6488	6424	10	11	13	15	17	19	21	
20	6916	6852	6788	6724	6660	6596	6532	6469	6405	20	21	23	25	28	30	32	
30	6899	6835	6771	6706	6642	6578	6514	6449	6385	30	32	34	36	39	41	43	
40	6882	6818	6753	6688	6624	6559	6495	6430	6366	40	43	45	47	49	52	54	
50	686[illegible]	6800	6735	6671	6606	6541	6476	6411	6346	50	54	56	58	60	63	65	

Sun's Alt.	5°	6°	7°	8°	14°	25°	34	42°	51°	61°	90°
sub.	17	13	11	9	7	9	11	13	15	17	18

Star's Alt.	5°	6°	7°	8°	9°	11°	12°	14°	18°	30°
sub.	15	11	9	7	5	4	3	2	1	0

THE LOGARITHMIC DIFFERENCE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°.)

App. Alt.	Horizontal Parallax. 53′	54′	55′	56′	57′	58′	59′	60′	61′	″ of Par.	Corr. for ″ of Par. sub. 0″	2″	4″	6″	8″	10″	Cor. for Alt.
° ′	9·99	9·99	9·99	9·99	9·99	9·99	9·99	9·99	9·99								
30 0	6848	6783	6718	6653	6588	6522	6457	6392	6327	0	0	2	4	6	9	11	
10	6831	6766	6700	6635	6569	6504	6439	6373	6308	10	11	13	15	17	20	22	sub.
20	6815	6749	6683	6617	6551	6485	6420	6354	6288	20	22	24	26	29	31	33	
30	6798	6732	6665	6599	6533	6467	6401	6335	6269	30	33	35	37	40	42	44	
40	6781	6714	6648	6581	6515	6449	6382	6316	6249	40	44	46	49	51	53	56	H.P.
50	6764	6697	6630	6564	6497	6430	6363	6296	6230	50	56	58	60	62	64	66	53′
31 0	6747	6680	6613	6546	6479	6412	6344	6277	6210	0	0	2	4	7	9	11	
10	6731	6663	6596	6528	6461	6393	6326	6258	6191	10	11	13	16	18	20	23	
20	6714	6646	6579	6511	6443	6375	6307	6240	6172	20	23	25	27	29	32	34	1 2
30	6697	6629	6561	6493	6425	6357	6289	6221	6153	30	34	36	38	41	43	46	2 3
40	6681	6612	6544	6476	6407	6339	6270	6202	6134	40	46	48	50	52	55	57	3 5
50	6664	6596	6527	6458	6389	6321	6252	6183	6115	50	57	59	62	64	66	68	4 6
32 0	6648	6579	6510	6441	6372	6303	6234	6165	6096	0	0	2	5	7	9	11	5 8
10	6631	6562	6493	6423	6354	6285	6215	6146	6077	10	11	14	16	18	21	23	6 10
20	6615	6545	6475	6406	6336	6267	6197	6127	6058	20	23	25	28	30	32	35	7 11
30	6598	6528	6458	6388	6318	6249	6179	6109	6039	30	35	37	40	42	44	47	8 13
40	6582	6512	6441	6371	6301	6231	6160	6090	6020	40	47	49	52	54	56	59	9 14
50	6565	6495	6424	6354	6283	6213	6142	6071	6001	50	59	61	63	66	68	71	
33 0	6549	6478	6407	6336	6265	6195	6124	6053	5982	0	0	2	5	7	9	12	
10	6533	6461	6390	6319	6248	6177	6106	6034	5963	10	12	14	17	19	21	24	
20	6516	6445	6373	6302	6230	6159	6087	6016	5944	20	24	26	29	31	33	36	
30	6500	6428	6356	6285	6213	6141	6069	5998	5926	30	36	38	41	43	45	48	
40	6484	6412	6340	6268	6195	6123	6051	5979	5907	40	48	50	53	55	58	60	
50	6468	6395	6323	6250	6178	6105	6033	5961	5888	50	60	63	65	68	70	72	
34 0	6451	6379	6306	6233	6160	6088	6015	5942	5869	0	0	2	5	7	10	12	
10	6435	6362	6289	6216	6143	6070	5997	5924	5851	10	12	15	17	19	22	24	
20	6419	6346	6273	6199	6126	6053	5979	5906	5833	20	24	27	29	32	34	37	
30	6403	6330	6256	6182	6109	6035	5961	5888	5814	30	37	39	42	44	47	49	
40	6387	6313	6239	6165	6091	6017	5943	5870	5796	40	49	52	54	57	59	62	
50	6371	6297	6223	6148	6074	6000	5926	5851	5777	50	62	64	67	69	72	74	
35 0	6355	6280	6206	6131	6057	5982	5908	5833	5759	0	0	2	5	7	10	12	
10	6339	6264	6189	6115	6040	5965	5890	5815	5740	10	12	15	17	20	22	25	
20	6323	6248	6173	6098	6023	5948	5872	5797	5722	20	25	27	30	32	35	38	
30	6307	6232	6156	6081	6006	5930	5855	5779	5704	30	38	40	43	45	48	50	
40	6292	6216	6140	6064	5989	5913	5837	5761	5686	40	50	53	55	58	61	63	
50	6276	6200	6124	6048	5971	5895	5819	5743	5667	50	63	66	68	71	74	76	
36 0	6260	6183	6107	6031	5954	5878	5802	5725	5649	0	0	2	5	8	10	13	
10	6244	6167	6091	6014	5938	5861	5784	5708	5631	10	13	15	18	20	23	26	
20	6228	6152	6075	5998	5921	5844	5767	5690	5613	20	26	28	31	33	36	39	H.P
30	6213	6136	6058	5981	5904	5827	5749	5672	5596	30	39	41	44	46	49	52	61
40	6197	6120	6042	5964	5887	5809	5732	5654	5577	40	52	54	57	59	62	65	
50	6181	6104	6026	5948	5870	5792	5714	5637	5559	50	65	67	70	73	75	78	
37 0	6166	6088	6009	5931	5853	5775	5697	5619	5541	0	0	3	5	8	10	13	1 2
10	6150	6072	5993	5915	5837	5758	5680	5601	5523	10	13	16	18	21	23	26	2 4
20	6135	6056	5977	5899	5820	5741	5662	5584	5505	20	26	29	31	34	37	39	3 5
30	6119	6040	5961	5882	5803	5724	5645	5566	5487	30	39	42	45	47	50	53	4 7
40	6104	6024	5945	5866	5787	5707	5628	5549	5469	40	53	56	58	61	63	66	5 9
50	6088	6009	5929	5850	5770	5690	5611	5531	5452	50	66	69	72	74	77	79	6 11
38 0	6073	5993	5913	5833	5753	5673	5594	5514	5434	0	0	3	5	8	11	13	7 13
10	6058	5977	5897	5817	5737	5657	5577	5496	5416	10	13	16	19	21	24	27	8 14
20	6042	5962	5881	5801	5721	5640	5560	5479	5399	20	27	29	32	35	37	40	9 16
30	6027	5946	5866	5785	5704	5623	5543	5462	5381	30	40	43	46	48	51	54	
40	6012	5931	5850	5769	5688	5607	5526	5445	5364	40	54	57	59	62	65	68	
50	5997	5915	5834	5753	5671	5590	5509	5427	5346	50	68	70	73	76	79	81	
39 0	5981	5900	5818	5736	5655	5573	5492	5410	5328	0	0	3	5	8	11	14	
10	5966	5884	5802	5721	5639	5557	5475	5393	5311	10	14	16	19	22	25	27	
20	5951	5869	5787	5705	5622	5540	5458	5376	5294	20	27	30	33	36	38	41	
30	5936	5854	5771	5689	5606	5524	5441	5359	5277	30	41	44	47	49	52	55	
40	5921	5838	5756	5673	5590	5507	5425	5342	5259	40	55	58	61	63	66	69	
50	5906	5823	5741	5657	5574	5491	5408	5325	5242	50	69	72	75	77	80	82	

Sun's Alt.	5°	6°	7°	8°	11	25	31°	40°	51°	64°	90°
sub.	17	13	11	9	7	9	11	13	15	17	18

Star's Alt.	5°	6	7	8	9°	11°	12°	14	18°	30
sub.	15	11	9	7	5	4	3	2	1	0

THE LOGARITHMIC DIFFERENCE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°.)

☽ App. Alt.	Horizontal Parallax. 53′	54′	55′	56′	57′	58′	59′	60′	61′	″ of Par.	Corr. for ″ of Par. *sub.* 0″	2″	4″	6″	8″	10″	Cor. for ′ of Alt.
° ′	9·99	9·99	9·99	9·99	9·99	9·99	9·99	9·99	9·99								
40 0	5891	5808	5724	5641	5558	5474	5391	5308	5225	0	0	3	6	8	11	14	*sub.*
10	5876	5793	5709	5625	5542	5458	5375	5291	5207	10	14	17	19	22	25	28	
20	5861	5777	5694	5610	5526	5442	5358	5274	5190	20	28	31	34	36	39	42	H.P.
30	5847	5762	5678	5594	5510	5426	5342	5257	5173	30	42	45	48	50	53	56	53′
40	5832	5747	5663	5578	5494	5410	5325	5241	5156	40	56	59	62	65	68	71	
50	5817	5732	5647	5563	5478	5393	5309	5224	5139	50	71	73	76	79	82	84	
41 0	5802	5717	5632	5547	5462	5377	5292	5207	5122	0	0	3	6	8	11	14	1′ 1
10	5787	5702	5617	5532	5446	5361	5276	5191	5105	10	14	17	20	23	26	28	2 3
20	5773	5687	5602	5516	5431	5345	5260	5174	5089	20	28	31	34	37	40	43	3 4
30	5758	5672	5587	5501	5415	5329	5243	5158	5072	30	43	46	49	51	54	57	4 6
40	5744	5658	5571	5485	5399	5313	5227	5141	5055	40	57	60	63	66	69	72	5 7
50	5729	5643	5556	5470	5384	5297	5211	5124	5038	50	72	75	78	81	83	86	6 8
42 0	5714	5628	5541	5455	5368	5281	5195	5108	5021	0	0	3	6	9	11	14	7 10
10	5700	5613	5526	5439	5352	5266	5179	5092	5005	10	14	17	20	23	26	29	8 11
20	5686	5599	5511	5424	5337	5250	5163	5075	4988	20	29	32	35	38	41	44	9 13
30	5671	5584	5496	5409	5322	5234	5147	5059	4972	30	44	47	49	52	55	58	
40	5657	5569	5482	5394	5306	5218	5131	5043	4955	40	58	61	64	67	70	73	
50	5643	5555	5467	5379	5291	5203	5115	5027	4939	50	73	76	79	82	85	87	
43 0	5628	5540	5452	5363	5275	5187	5099	5010	4922	0	0	3	6	9	12	15	
10	5614	5526	5437	5349	5260	5171	5083	4994	4906	10	15	18	21	24	26	30	
20	5600	5511	5422	5334	5245	5156	5067	4978	4890	20	30	32	35	38	41	45	
30	5586	5497	5408	5319	5230	5141	5051	4962	4873	30	45	47	50	53	56	60	
40	5572	5482	5393	5304	5214	5125	5036	4946	4857	40	60	63	65	68	71	75	
50	5558	5468	5378	5289	5199	5110	5020	4930	4841	50	75	78	81	84	87	89	
44 0	5544	5454	5364	5274	5184	5094	5004	4914	4825	0	0	3	6	9	12	15	
10	5530	5439	5349	5259	5169	5079	4989	4899	4809	10	15	18	21	24	27	30	
20	5516	5425	5335	5245	5154	5064	4973	4883	4793	20	30	33	36	39	42	45	
30	5502	5411	5320	5230	5139	5048	4958	4867	4777	30	45	48	51	54	57	61	
40	5488	5397	5306	5215	5124	5033	4942	4851	4760	40	61	64	67	70	73	76	
50	5474	5383	5292	5200	5109	5018	4927	4836	4744	50	76	79	82	85	88	90	
45 0	5460	5369	5277	5186	5094	5003	4911	4820	4728	0	0	3	6	9	12	15	
10	5446	5355	5263	5171	5080	4988	4896	4804	4713	10	15	18	21	24	27	31	
20	5433	5341	5249	5157	5065	4973	4881	4789	4697	20	31	34	37	40	43	46	
30	5419	5327	5235	5142	5050	4958	4866	4774	4681	30	46	49	52	55	58	62	
40	5405	5313	5220	5128	5035	4943	4851	4758	4666	40	62	65	68	71	74	77	
50	5392	5299	5206	5113	5021	4928	4835	4743	4650	50	77	80	83	87	90	92	
46 0	5378	5285	5192	5099	5006	4913	4820	4727	4634	0	0	3	6	9	12	15	
10	5365	5271	5178	5085	4992	4898	4805	4712	4619	10	15	19	22	25	28	31	
20	5351	5258	5164	5071	4977	4884	4790	4697	4603	20	31	34	37	40	44	47	H.P.
30	5338	5244	5150	5057	4963	4869	4775	4682	4588	30	47	50	53	56	59	63	61
40	5324	5230	5136	5042	4948	4854	4760	4666	4572	40	63	66	69	72	75	78	
50	5311	5217	5123	5028	4934	4840	4745	4651	4557	50	78	82	85	88	91	94	
47 0	5298	5203	5109	5014	4920	4825	4731	4636	4542	0	0	3	6	9	13	16	1 2
10	5284	5190	5095	5000	4906	4811	4716	4621	4527	10	16	19	22	25	28	32	2 3
20	5271	5176	5081	4986	4891	4796	4701	4606	4511	20	32	35	38	41	44	48	3 5
30	5258	5163	5068	4972	4877	4782	4687	4592	4496	30	48	51	54	56	60	64	4 6
40	5245	5149	5054	4959	4863	4768	4672	4577	4481	40	64	66	70	73	76	80	5 8
50	5232	5136	5040	4945	4849	4753	4658	4562	4466	50	80	83	86	89	93	96	6 10
48 0	5218	5123	5027	4931	4835	4739	4643	4547	4451	0	0	3	6	10	13	16	7 11
10	5206	5109	5013	4917	4821	4725	4629	4533	4436	10	16	19	22	26	29	32	8 13
20	5193	5096	5000	4903	4807	4711	4614	4518	4421	20	32	35	39	42	45	48	9 14
30	5180	5083	4986	4890	4793	4696	4600	4503	4406	30	48	52	55	58	61	65	
40	5167	5070	4973	4876	4779	4682	4585	4488	4391	40	65	67	71	74	78	81	
50	5154	5057	4960	4862	4765	4668	4571	4474	4376	50	81	84	87	90	94	97	
49 0	5141	5044	4946	4849	4751	4654	4556	4459	4361	0	0	3	6	10	13	16	
10	5128	5031	4933	4835	4738	4640	4542	4444	4347	10	16	19	23	26	29	33	
20	5116	5018	4920	4822	4724	4626	4528	4430	4332	20	33	36	39	42	46	49	
30	5103	5005	4907	4809	4710	4612	4514	4416	4318	30	49	52	56	59	62	66	
40	5091	4992	4894	4795	4697	4598	4500	4402	4303	40	66	69	72	75	79	82	
50	5078	4979	4881	4782	4683	4585	4486	4387	4289	50	82	85	89	92	95	98	

Sun's Alt.	5°	6°	7°	8°	14°	25°	34°	42°	51°	64°	90°
sub.	17	13	11	9	7	9	11	13	15	17	18

Star's Alt.	5°	6°	7°	8°	9°	11°	12°	14°	18°	30°
sub.	15	11	9	7	5	4	3	2	1	0

THE LOGARITHMIC DIFFERENCE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°.)

☽ App. Alt.	Horizontal Parallax. 53′	54′	55′	56′	57′	58′	59′	60′	61′	″ of Par.	Corr. for ″ of Par. sub. 0″	2″	4	6″	8″	10	Cor. for ″ of Alt.
° ′	9·99	9·99	9·99	9·99	9·99	9·99	9·99	9·99	9·99								
50 0	5065	4966	4867	4769	4670	4571	4472	4373	4274	0	0	3	7	10	13	16	
10	5053	4954	4855	4755	4656	4557	4458	4359	4260	10	16	20	23	26	30	33	sub.
20	5040	4941	4842	4742	4643	4544	4444	4345	4246	20	33	36	40	43	46	50	
30	5028	4928	4829	4729	4630	4530	4430	4331	4231	30	50	53	56	60	63	67	H.P.
40	5016	4916	4816	4716	4616	4516	4417	4317	4217	40	67	70	73	77	80	83	53′
50	5003	4903	4803	4703	4603	4503	4403	4303	4203	50	83	87	90	93	97	100	
51 0	4991	4891	4790	4690	4590	4489	4389	4289	4188	0	0	3	7	10	13	17	1 1
10	4979	4878	4778	4677	4577	4476	4376	4275	4174	10	17	20	23	26	30	34	2 2
20	4967	4866	4765	4664	4564	4463	4362	4261	4160	20	34	37	40	43	47	50	3 4
30	4954	4853	4752	4651	4550	4449	4348	4247	4146	30	50	54	57	60	64	67	4 5
40	4942	4841	4740	4639	4537	4436	4335	4234	4133	40	67	71	74	78	81	84	5 6
50	4930	4829	4727	4626	4524	4423	4321	4220	4119	50	84	88	91	95	98	101	6 7
52 0	4918	4816	4715	4613	4511	4410	4308	4206	4105	0	0	3	7	10	14	17	7 8
10	4906	4804	4702	4600	4499	4397	4295	4193	4091	10	17	20	24	27	31	34	8 10
20	4894	4792	4690	4588	4486	4384	4281	4179	4077	20	34	37	41	44	48	51	9 11
30	4882	4780	4678	4575	4473	4371	4268	4166	4064	30	51	54	58	61	65	68	
40	4871	4768	4665	4563	4460	4358	4255	4153	4050	40	68	72	75	79	82	86	H.P.
50	4859	4756	4653	4550	4448	4345	4242	4139	4036	50	86	89	93	96	99	102	61′
53 0	4847	4744	4641	4538	4435	4332	4229	4126	4023	0	0	3	7	10	14	17	
10	4835	4732	4629	4526	4422	4319	4216	4113	4009	10	17	21	24	27	31	34	1 1
20	4824	4720	4617	4513	4410	4306	4203	4099	3996	20	34	39	41	45	48	52	2 3
30	4812	4708	4605	4501	4397	4294	4190	4086	3983	30	52	55	59	62	66	69	3 4
40	4800	4697	4593	4489	4385	4281	4177	4073	3969	40	69	73	76	80	83	87	4 6
50	4789	4685	4581	4476	4372	4268	4164	4060	3956	50	87	90	94	97	101	104	5 7
54 0	4777	4673	4568	4464	4360	4255	4151	4047	3942	0	0	3	7	10	14	17	6 8
10	4766	4661	4557	4452	4348	4243	4139	4034	3930	10	17	21	24	28	31	35	7 10
20	4755	4650	4545	4440	4336	4231	4126	4021	3917	20	35	39	42	45	49	52	8 11
30	4743	4638	4533	4428	4324	4219	4114	4009	3904	30	52	56	59	63	66	70	9 13
40	4732	4627	4522	4417	4311	4206	4101	3996	3891	40	70	74	77	81	84	88	
50	4721	4615	4510	4405	4299	4194	4089	3983	3878	50	88	91	95	98	102	105	
55 0	4709	4604	4498	4393	4287	4182	4076	3971	3865	0	0	3	7	11	14	18	
10	4698	4593	4487	4381	4275	4170	4064	3958	3852	10	18	21	25	28	32	35	
20	4687	4581	4475	4369	4263	4157	4051	3946	3840	20	35	39	42	46	49	53	H.P.
30	4676	4570	4464	4358	4251	4145	4039	3933	3827	30	53	57	61	64	67	71	53′
40	4665	4559	4452	4346	4240	4133	4027	3920	3814	40	71	74	78	82	85	89	
50	4654	4548	4441	4334	4228	4121	4014	3908	3801	50	89	92	96	99	103	106	
56 0	4643	4536	4429	4323	4216	4109	4002	3895	3788	0	0	4	7	11	14	18	1 1
10	4632	4525	4418	4311	4204	4097	3990	3883	3776	10	18	21	25	28	32	36	2 2
20	4622	4514	4407	4300	4192	4085	3978	3871	3763	20	36	39	43	46	50	54	3 3
30	4611	4503	4396	4288	4181	4073	3966	3858	3751	30	54	57	61	64	68	72	4 4
40	4600	4492	4385	4277	4169	4062	3954	3846	3739	40	72	75	79	82	86	90	5 5
50	4589	4481	4373	4266	4158	4050	3942	3834	3726	50	90	93	97	101	104	108	6 6
57 0	4578	4470	4362	4254	4146	4038	3930	3822	3714	0	0	4	7	11	14	18	7 7
10	4568	4460	4351	4243	4135	4027	3918	3810	3702	10	18	22	25	29	32	36	8 8
20	4558	4449	4341	4232	4124	4015	3907	3798	3690	20	36	40	43	47	51	54	9 9
30	4547	4439	4330	4221	4112	4004	3895	3786	3678	30	54	58	61	65	69	73	
40	4537	4428	4319	4210	4101	3992	3883	3774	3666	40	73	76	80	83	87	91	H.P.
50	4526	4417	4308	4199	4090	3981	3872	3763	3654	50	91	94	98	102	105	109	61′
58 0	4516	4407	4297	4188	4079	3969	3860	3751	3642	0	0	4	7	11	15	18	
10	4506	4396	4287	4177	4068	3958	3849	3739	3630	10	18	22	25	29	33	37	1 1
20	4496	4386	4276	4166	4057	3947	3837	3728	3618	20	37	40	44	48	51	55	2 2
30	4485	4375	4266	4156	4046	3936	3826	3716	3606	30	55	59	62	66	70	73	3 4
40	4475	4365	4255	4145	4035	3925	3815	3705	3595	40	73	77	81	84	88	92	4 6
50	4465	4355	4244	4134	4024	3914	3803	3693	3583	50	[illegible]	95	99	103	107	110	5 6
59 0	4455	4344	4234	4123	4013	3903	3792	3682	3571	0	0	4	7	11	15	18	6 7
10	4445	4334	4224	4113	4002	3892	3781	3670	3560	10	18	22	26	29	33	37	7 8
20	4435	4324	4213	4102	3992	3881	3770	3659	3548	20	37	41	44	48	52	55	8 10
30	4425	4314	4203	4092	3981	3870	3759	3648	3537	30	55	59	63	67	70	74	9 11
40	4415	4304	4193	4082	3970	3859	3748	3637	3526	40	74	78	81	85	89	93	
50	4405	4294	4182	4071	[illegible]	3848	[illegible]	3626	[illegible]	50	[illegible]	96	[illegible]	104	108	111	

Sun's Alt. 5° 6° 7° 8° 11 25 31° 42° 51° 64° 90°
sub. 17 13 11 9 7 9 11 13 15 17 18

Star's Alt. 5° 6 7 8° 9° 11° 12° 14° 18 30°
sub. 15 11 9 7 5 4 3 2 1 0

THE LOGARITHMIC DIFFERENCE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°.)

☽ App. Alt.	Horizontal Parallax. 53′	54′	55′	56′	57′	58′	59′	60′	61′	″ of Par.	Corr. for ″ of Par. *sub.* 0″	2″	4″	6″	8″	10″	Cor. for ′ of Alt.
	9·99	9·99	9·99	9·99	9·99	9·99	9·99	9·99	9·99								
60° 0′	4395	4284	4172	4061	3949	3838	3726	3615	3503	0	0	4	7	11	15	19	*sub.*
10	4386	4274	4162	4051	3939	3827	3715	3604	3492	10	19	22	26	30	33	37	H.P.
20	4376	4264	4152	4040	3928	3817	3705	3593	3481	20	37	41	45	48	52	56	53′
30	4366	4254	4142	4030	3918	3806	3694	3582	3470	30	56	60	63	67	71	75	
40	4357	4245	4132	4020	3908	3796	3683	3571	3459	40	75	79	82	86	90	94	1′ 1
50	4347	4235	4122	4010	3898	3785	3673	3560	3448	50	94	97	101	105	109	112	2 2
61 0	4338	4225	4113	4000	3887	3775	3662	3549	3437	0	0	4	7	11	15	19	3 3
10	4328	4216	4103	3990	3877	3764	3652	3539	3426	10	19	23	26	30	34	38	4 4
20	4319	4206	4093	3980	3867	3754	3641	3528	3415	20	38	41	45	49	53	57	5 4
30	4310	4197	4084	3970	3857	3744	3631	3518	3405	30	57	60	64	68	72	76	6 5
40	4301	4187	4074	3961	3847	3734	3621	3507	3394	40	76	79	83	87	91	95	7 6
50	4291	4178	4064	3951	3837	3724	3610	3497	3383	50	95	98	102	106	110	113	8 7
62 0	4282	4168	4055	3941	3827	3714	3600	3486	3373	0	0	4	8	11	15	19	9 8
10	4273	4159	4045	3931	3818	3704	3590	3476	3362	10	19	23	27	30	34	38	
20	4264	4150	4036	3922	3808	3694	3580	3466	3352	20	38	42	46	49	53	57	H.P.
30	4255	4141	4027	3912	3798	3684	3570	3456	3342	30	57	61	65	68	72	76	61′
40	4246	4132	4017	3903	3789	3674	3560	3446	3331	40	76	80	84	88	91	95	
50	4237	4122	4008	3893	3779	3664	3550	3435	3321	50	95	99	103	107	111	114	1′ 1
63 0	4228	4113	3999	3884	3769	3655	3540	3425	3310	0	0	4	8	11	15	19	2 2
10	4219	4104	3989	3875	3760	3645	3530	3415	3300	10	19	23	27	31	34	38	3 3
20	4210	4095	3980	3865	3750	3635	3520	3405	3290	20	38	42	46	50	54	58	4 4
30	4202	4087	3971	3856	3741	3626	3511	3395	3280	30	58	61	65	69	73	77	5 5
40	4193	4078	3962	3847	3732	3616	3501	3386	3270	40	77	81	85	88	92	96	6 7
50	4184	4069	3953	3838	3722	3607	3491	3376	3260	50	96	100	104	108	112	115	7 8
64 0	4175	4060	3944	3828	3713	3597	3481	3366	3250	0	0	4	8	12	15	19	8 9
10	4167	4051	3935	3820	3704	3588	3472	3356	3241	10	19	23	27	31	35	39	9 10
20	4159	4043	3927	3811	3695	3579	3463	3347	3231	20	39	42	46	50	54	58	
30	4150	4034	3918	3802	3686	3570	3454	3337	3221	30	58	62	66	70	73	77	
40	4142	4026	3909	3793	3677	3561	3444	3328	3212	40	77	81	85	89	93	97	
50	4134	4017	3901	3784	3668	3551	3435	3318	3202	50	97	101	105	109	113	116	
65 0	4125	4009	3892	3776	3659	3542	3426	3309	3192	0	0	4	8	12	15	19	
10	4117	4001	3884	3767	3650	3533	3417	3300	3183	10	19	23	27	31	35	39	
20	4109	3992	3875	3758	3641	3524	3407	3291	3174	20	39	43	47	51	54	59	
30	4101	3984	3867	3750	3633	3516	3398	3281	3164	30	59	62	66	70	74	78	H.P.
40	4093	3976	3858	3741	3624	3507	3389	3272	3155	40	78	82	86	90	94	98	53′
50	4085	3967	3850	3733	3615	3498	3380	3263	3146	50	98	102	106	109	113	117	
66 0	4077	3959	3841	3724	3606	3489	3371	3254	3136	0	0	4	8	12	16	20	1′ 1
10	4069	3951	3833	3716	3598	3480	3363	3245	3127	10	20	24	27	31	35	40	2 2
20	4061	3943	3825	3708	3590	3472	3354	3236	3118	20	40	43	47	51	55	59	3 3
30	4053	3935	3817	3699	3581	3463	3345	3227	3110	30	59	63	67	71	75	79	4 3
40	4045	3927	3809	3691	3573	3455	3337	3219	3101	40	79	83	86	90	94	98	5 4
50	4038	3919	3801	3683	3565	3446	3328	3210	3092	50	98	102	106	110	114	118	6 5
67 0	4030	3912	3793	3675	3556	3438	3320	3201	3083	0	0	4	8	12	16	20	7 6
10	4023	3904	3785	3667	3548	3430	3311	3193	3074	10	20	24	28	32	36	40	8 6
20	4015	3896	3778	3659	3540	3422	3303	3184	3066	20	40	43	47	51	55	59	9 7
30	4008	3889	3770	3651	3532	3414	3295	3176	3057	30	59	63	67	71	75	79	
40	4000	3881	3762	3643	3524	3405	3286	3167	3048	40	79	83	87	91	95	99	H.P.
50	3993	3874	3755	3635	3516	3397	3278	3159	3040	50	99	103	107	111	115	119	61′
68 0	3985	3866	3747	3628	3508	3389	3270	3150	3031	0	0	4	8	12	16	20	
10	3978	3859	3739	3620	3501	3381	3262	3142	3023	10	20	24	28	32	36	40	1′ 1
20	3971	3852	3732	3613	3493	3373	3254	3134	3015	20	40	44	48	52	56	60	2 2
30	3964	3844	3725	3605	3485	3366	3246	3126	3007	30	60	64	68	72	76	80	3 2
40	3957	3837	3717	3598	3478	3358	3238	3118	2998	40	80	84	88	92	96	100	4 3
50	3950	3830	3710	3590	3470	3350	3230	3110	2990	50	100	104	108	112	116	120	5 4
69 0	3943	3823	3703	3583	3462	3342	3222	3102	2982	0	0	4	8	12	16	20	6 5
10	3936	3816	3695	3575	3455	3335	3215	3095	2974	10	20	24	28	32	36	40	7 5
20	3929	3809	3688	3568	3448	3327	3207	3087	2966	20	40	44	48	52	56	60	8 6
30	3922	3802	3681	3561	3440	3320	3199	3079	2959	30	60	64	68	72	76	80	9 7
40	3915	3795	3674	3554	3433	3312	3192	3071	2951	40	80	84	88	92	96	101	
50	3909	3788	3667	3546	3426	3305	3184	3064	2943	50	101	105	109	113	117	120	

Sun's Alt.	5	6°	7	8	14°	25°	31	42	51°	64°	90°
sub.	17	13	11	9	7	9	11	13	15	17	18

Star's Alt.	5	6°	7°	8°	9°	11	12°	14°	18°	30°
sub.	15	11	9	7	5	4	3	2	1	0

THE LOGARITHMIC DIFFERENCE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°.)

☽ App. Alt.	Horizontal Parallax. 53′	54′	55′	56′	57′	58′	59′	60′	61′	″ of Par.	Corr. for ″ of Par. sub. 0	2	4	6	8	10	Cor. for ′ of Alt.
	9·99	9·99	9·99	9·99	9·99	9·99	9·99	9·99	9·99								
70 0	3902	3781	3660	3539	3418	3298	3177	3056	2935	0	0	4	8	12	16	20	
10	3895	3774	3653	3532	3411	3290	3169	3049	2928	10	20	24	28	32	36	40	*sub*
20	3889	3768	3647	3526	3404	3283	3162	3041	2920	20	40	44	48	52	56	61	
30	3882	3761	3640	3519	3398	3276	3155	3034	2913	30	61	65	69	73	77	81	
40	3876	3755	3633	3512	3391	3269	3148	3027	2905	40	81	85	89	93	97	101	
50	3869	3748	3626	3505	3384	3262	3141	3019	2898	50	101	105	109	113	117	121	
71 0	3863	3741	3620	3498	3377	3255	3133	3012	2890	0	0	4	8	12	16	20	
10	3857	3735	3613	3492	3370	3248	3127	3005	2883	10	20	24	28	32	37	41	1′ 1
20	3851	3729	3607	3485	3363	3242	3120	2998	2876	20	41	45	49	53	57	61	2 1
30	3844	3722	3601	3479	3357	3235	3113	2991	2869	30	61	65	69	73	77	81	3 2
40	3838	3716	3594	3472	3350	3228	3106	2984	2862	40	81	85	89	93	98	102	4 2
50	3832	3710	3588	3466	3343	3221	3099	2977	2855	50	102	106	110	114	118	122	5 3
72 0	3826	3704	3581	3459	3337	3214	3092	2970	2848	0	0	4	8	12	16	20	6 4
10	3820	3698	3575	3453	3330	3208	3085	2963	2841	10	20	24	29	33	37	41	7 4
20	3814	3692	3569	3447	3324	3202	3079	2957	2834	20	41	45	49	53	57	61	8 5
30	3808	3686	3563	3440	3318	3195	3073	2950	2827	30	61	65	69	74	78	82	9 5
40	3803	3680	3557	3434	3312	3189	3066	2943	2821	40	82	86	90	94	98	102	
50	3797	3674	3551	3428	3305	3182	3060	2937	2814	50	102	106	111	115	119	123	
73 0	3791	3668	3545	3422	3299	3176	3053	2930	2807	0	0	4	8	12	16	20	
10	3785	3662	3539	3416	3293	3170	3047	2924	2801	10	20	25	29	33	37	41	
20	3780	3657	3533	3410	3287	3164	3041	2918	2794	20	41	45	49	53	57	62	
30	3774	3651	3528	3404	3281	3158	3035	2911	2788	30	62	66	70	74	78	82	
40	3769	3645	3522	3398	3275	3152	3028	2905	2782	40	82	86	90	95	98	103	
50	3763	3640	3516	3393	3269	3146	3022	2899	2775	50	103	107	111	115	119	123	
74 0	3757	3634	3510	3387	3263	3140	3016	2892	2769	0	0	4	8	12	16	21	
10	3752	3629	3505	3381	3258	3134	3010	2887	2763	10	21	25	29	33	37	41	
20	3747	3623	3500	3376	3252	3128	3004	2881	2757	20	41	45	49	54	58	62	
30	3742	3618	3494	3370	3246	3123	2999	2875	2751	30	62	66	70	74	78	83	
40	3737	3613	3489	3365	3241	3117	2993	2869	2745	40	83	87	91	95	99	103	
50	3731	3607	3483	3359	3235	3111	2987	2863	2739	50	103	107	112	116	120	124	
75 0	3726	3602	3478	3354	3230	3105	2981	2857	2733	0	0	4	8	12	17	21	
10	3721	3597	3473	3349	3224	3100	2976	2852	2727	10	21	25	29	33	37	41	
20	3716	3592	3468	3343	3219	3095	2970	2846	2722	20	41	46	50	54	58	62	
30	3712	3587	3463	3338	3214	3089	2965	2841	2716	30	62	66	70	75	79	83	
40	3707	3582	3458	3333	3209	3084	2960	2835	2710	40	83	87	91	95	100	104	
50	3702	3577	3453	3328	3203	3079	2954	2829	2705	50	104	108	112	116	120	124	
76 0	3697	3572	3448	3323	3198	3073	2949	2824	2699	0	0	4	8	12	17	21	
10	3692	3568	3443	3318	3193	3068	2944	2819	2694	10	21	25	29	33	37	42	
20	3688	3563	3438	3313	3188	3063	2939	2814	2689	20	42	46	50	54	58	62	
30	3683	3558	3433	3308	3183	3058	2933	2808	2684	30	62	67	71	75	79	83	
40	3679	3554	3429	3304	3178	3053	2928	2803	2678	40	83	88	92	96	100	104	
50	3674	3549	3424	3299	3174	3048	2923	2798	2673	50	104	108	113	117	121	125	
77 0	3670	3544	3419	3294	3169	3043	2918	2793	2668	0	0	4	8	12	17	21	
10	3665	3540	3415	3289	3164	3039	2914	2788	2663	10	21	25	29	33	38	42	1′ 0
20	3661	3536	3410	3285	3160	3034	2909	2783	2658	20	42	46	50	54	58	63	2 1
30	3657	3531	3406	3281	3155	3030	2904	2779	2653	30	63	67	71	75	79	84	3 1
40	3653	3527	3402	3276	3151	3025	2899	2774	2648	40	84	88	92	96	100	105	4 2
50	3648	3523	3397	3272	3146	3020	2895	2769	2644	50	105	109	113	117	121	126	5 2
78 0	3644	3519	3393	3267	3141	3016	2890	2764	2639	0	0	4	8	13	17	21	6 3
10	3640	3515	3389	3263	3137	3012	2886	2760	2634	10	21	25	29	33	38	42	7 3
20	3636	3511	3385	3259	3133	3007	2881	2756	2630	20	42	46	50	54	59	63	8 4
30	3633	3507	3381	3255	3129	3003	2877	2751	2625	30	63	67	71	76	80	84	9 4
40	3629	3503	3377	3251	3125	2999	2873	2747	2621	40	84	88	92	97	101	105	
50	3625	3499	3373	3247	3121	2995	2868	2742	2616	50	105	109	113	118	122	126	
79 0	3621	3495	3369	3243	3116	2990	2864	2738	2612	0	0	4	8	13	17	21	
10	3617	3491	3365	3239	3113	2986	2860	2734	2608	10	21	25	29	34	38	42	
20	3614	3488	3361	3235	3109	2982	2856	2730	2604	20	42	46	50	55	59	63	
30	3610	3484	3358	3231	3105	2979	2852	2726	2600	30	63	67	71	76	80	84	
40	3607	3480	3354	3228	3101	2975	2848	2722	2596	40	84	87	93	97	101	105	
50	3603	3477	3350	3224	3097	2971	2844	2718	2591	50	105	110	114	118	122	126	

Sun's Alt.	5°	6°	7°	8°	14°	25°	34°	42°	51°	64°	90°
sub	17	12	11	9	7	9	11	13	15	17	18

Star's Alt.	5°	6°	7°	8°	9°	11°	12°	14°	18°	30°
sub.	15	11	5	7	5	4	3	2	1	0

THE LOGARITHMIC DIFFERENCE

(Barometer, 30 inches. Fahrenheit's Thermometer, 50°.)

☽ App. Alt.	Horizontal Parallax. 53′	54′	55′	56′	57′	58′	59′	60′	61′	″ of Par.	Corr. for ″ of Par. *sub.* 0″	2″	4″	6″	8″	10″	Cor. for ′ of Alt.
	9·99	9·99	9·99	9·99	9·99	9·99	9·99	9·99	9·99								
80° 0′	3600	3473	3347	3220	3094	2967	2840	2714	2587	0							
10	3596	3470	3343	3217	3090	2963	2837	2710	2584	10							
20	3593	3467	3340	3213	3087	2960	2833	2707	2580	20							*sub.*
30	3590	3463	3337	3210	3083	2956	2830	2703	2576	30							
40	3587	3460	3333	3206	3080	2953	2826	2699	2573	40							
50	3584	3457	3330	3203	3076	2949	2823	2696	2569	50							
81 0	3580	3453	3327	3200	3073	2946	2819	2692	2565	0							
10	3577	3451	3324	3197	3070	2943	2816	2689	2562	10							H.P.
20	3575	3448	3321	3194	3067	2940	2813	2686	2559	20							53
30	3572	3445	3318	3191	3063	2936	2809	2682	2555	30							
40	3569	3442	3315	3188	3060	2933	2806	2679	2552	40							
50	3566	3439	3312	3184	3057	2930	2803	2676	2549	50							1′ 0
82 0	3563	3436	3309	3181	3054	2927	2800	2673	2545	0	0	4	8	13	17	21	2 0
10	3561	3433	3306	3179	3052	2924	2797	2670	2542	10	21	25	29	34	38	42	3 1
20	3558	3431	3303	3176	3049	2921	2794	2667	2539	20	42	46	51	55	59	63	4 1
30	3555	3428	3301	3173	3046	2919	2791	2664	2537	30	63	68	72	76	80	84	5 1
40	3553	3425	3298	3171	3043	2916	2788	2661	2534	40	84	89	93	97	101	106	6 2
50	3550	3423	3295	3168	3041	2913	2786	2658	2531	50	106	110	114	118	123	127	7 2
83 0	3548	3420	3293	3166	3038	2911	2783	2656	2528	0							8 3
10	3546	3418	3291	3164	3036	2909	2781	2654	2526	10							9 3
20	3543	3416	3289	3162	3034	2907	2779	2652	2524	20							
30	3541	3414	3286	3159	3031	2904	2776	2649	2521	30							
40	3539	3411	3284	3156	3029	2901	2773	2646	2518	40							
50	3537	3409	3282	3154	3027	2899	2771	2643	2516	50							
84 0	3535	3407	3279	3151	3024	2896	2768	2640	2513	0							
10	3533	3405	3277	3149	3022	2894	2766	2638	2511	10							
20	3531	3403	3275	3147	3020	2892	2764	2636	2508	20							
30	3529	3401	3273	3145	3018	2890	2762	2634	2506	30							
40	3527	3399	3271	3143	3016	2888	2760	2632	2504	40							
50	3525	3397	3269	3141	3014	2886	2758	2630	2502	50							
85 0	3523	3396	3268	3140	3013	2884	2756	2628	2500	0							
10	3522	3394	3266	3138	3010	2882	2754	2626	2498	10							
20	3520	3392	3264	3136	3007	2880	2752	2624	2496	20							
30	3518	3391	3263	3134	3006	2878	2750	2621	2494	30							
40	3517	3389	3261	3133	3005	2877	2749	2620	2493	40							
50	3516	3388	3259	3131	3003	2875	2747	2619	2491	50							
86 0	3514	3386	3258	3130	3002	2874	2746	2617	2489	0							
10	3513	3385	3257	3128	3000	2872	2744	2616	2487	10							
20	3511	3383	3255	3127	2999	2871	2743	2614	2486	20							
30	3510	3382	3253	3126	2998	2869	2741	2613	2485	30							H.P.
40	3509	3381	3252	3124	2996	2868	2740	2612	2483	40							60′
50	3508	3380	3251	3123	2995	2867	2739	2610	2482	50							
87 0	3507	3379	3250	3122	2994	2866	2738	2609	2481	0	0	4	9	13	17	21	
10	3506	3378	3250	3121	2993	2865	2736	2608	2480	10	21	25	30	34	38	43	1′ 0
20	3505	3377	3249	3120	2992	2864	2735	2607	2479	20	43	47	52	56	60	64	2 0
30	3504	3376	3248	3119	2991	2863	2734	2606	2478	30	64	68	73	77	81	85	3 0
40	3503	3375	3247	3119	2990	2862	2734	2605	2477	40	85	90	94	98	102	107	4 0
50	3502	3374	3246	3118	2989	2861	2733	2604	2476	50	107	111	115	119	124	128	5 1
88 0	3501	3374	3245	3117	2989	2860	2732	2603	2475	0							6 1
10	3501	3373	3244	3116	2988	2860	2731	2602	2474	10							7 1
20	3500	3373	3244	3116	2987	2859	2731	2602	2474	20							8 1
30	3500	3372	3244	3115	2987	2858	2730	2601	2473	30							9 1
40	3499	3371	3243	3115	2986	2858	2729	2601	2473	40							
50	3499	3371	3243	3114	2986	2858	2729	2600	2472	50							
89 0	3499	3371	3242	3114	2985	2857	2729	2600	2472	0							
10	3499	3370	3242	3113	2985	2857	2728	2600	2471	10							
20	3498	3370	3242	3113	298[illegible]	2856	2728	2599	2471	20							
30	3498	3370	3241	3113	2985	2856	2728	2599	2471	30							
40	3498	3370	3241	3113	2984	2856	2727	2599	2471	40							
50	3498	3370	3241	3113	2984	2856	2727	2599	2470	50							

Sun's Alt.	5°	6°	7°	8°	14°	25°	34°	42°	51°	64°	90°
sub.	17	13	11	9	7	9	11	13	15	17	18

Star's Alt.	5°	6°	7°	8°	9°	11°	12°	14°	18°	30°
sub.	15	11	9	7	5	4	3	2	1	0

PROPORTIONAL LOGARITHMS

sec. ″	0h 0m	0h 1m	0h 2m	0h 3m	0h 4m	0h 5m	0h 6m	0h 7m	0h 8m	0h 9m	sec. ″
0		2·2553	1·9542	1·7782	1·6532	1·5563	1·4771	1·4102	1·3522	1·3010	0
1	4·0334	2·2481	1·9506	1·7757	1·6514	1·5549	1·4759	1·4091	1·3513	1·3002	1
2	3·7324	2·2410	1·9471	1·7734	1·6496	1·5534	1·4747	1·4081	1·3504	1·2994	2
3	3·5563	2·2341	1·9435	1·7710	1·6478	1·5520	1·4735	1·4071	1·3495	1·2986	3
4	3·4314	2·2272	1·9400	1·7686	1·6460	1·5505	1·4723	1·4061	1·3486	1·2978	4
5	3·3345	2·2205	1·9365	1·7663	1·6443	1·5491	1·4711	1·4050	1·3477	1·2970	5
6	3·2553	2·2139	1·9331	1·7639	1·6425	1·5477	1·4699	1·4040	1·3468	1·2962	6
7	3·1883	2·2073	1·9296	1·7616	1·6407	1·5463	1·4688	1·4030	1·3459	1·2954	7
8	3·1303	2·2009	1·9262	1·7593	1·6390	1·5449	1·4676	1·4020	1·3450	1·2946	8
9	3·0792	2·1946	1·9228	1·7570	1·6372	1·5435	1·4664	1·4010	1·3441	1·2939	9
10	3·0334	2·1883	1·9195	1·7547	1·6355	1·5421	1·4652	1·4000	1·3432	1·2931	10
11	2·9920	2·1822	1·9162	1·7524	1·6337	1·5407	1·4640	1·3989	1·3423	1·2923	11
12	2·9542	2·1761	1·9128	1·7501	1·6320	1·5393	1·4629	1·3979	1·3415	1·2915	12
13	2·9195	2·1701	1·9096	1·7479	1·6303	1·5379	1·4617	1·3969	1·3406	1·2907	13
14	2·8873	2·1642	1·9063	1·7456	1·6286	1·5365	1·4605	1·3959	1·3397	1·2899	14
15	2·8573	2·1584	1·9031	1·7434	1·6269	1·5351	1·4594	1·3949	1·3388	1·2891	15
16	2·8293	2·1526	1·8999	1·7412	1·6252	1·5337	1·4582	1·3939	1·3379	1·2883	16
17	2·8030	2·1469	1·8967	1·7390	1·6235	1·5324	1·4571	1·3929	1·3371	1·2876	17
18	2·7782	2·1413	1·8935	1·7368	1·6218	1·5310	1·4559	1·3919	1·3362	1·2868	18
19	2·7547	2·1358	1·8904	1·7346	1·6201	1·5296	1·4548	1·3910	1·3353	1·2860	19
20	2·7324	2·1303	1·8873	1·7324	1·6184	1·5283	1·4536	1·3900	1·3344	1·2852	20
21	2·7112	2·1249	1·8842	1·7302	1·6168	1·5269	1·4525	1·3890	1·3336	1·2845	21
22	2·6910	2·1196	1·8811	1·7281	1·6151	1·5256	1·4514	1·3880	1·3327	1·2837	22
23	2·6717	2·1143	1·8781	1·7259	1·6135	1·5242	1·4502	1·3870	1·3319	1·2829	23
24	2·6532	2·1091	1·8751	1·7238	1·6118	1·5229	1·4491	1·3860	1·3310	1·2821	24
25	2·6355	2·1040	1·8721	1·7217	1·6102	1·5215	1·4480	1·3851	1·3301	1·2814	25
26	2·6184	2·0989	1·8691	1·7196	1·6085	1·5202	1·4468	1·3841	1·3293	1·2806	26
27	2·6021	2·0939	1·8661	1·7175	1·6069	1·5189	1·4457	1·3831	1·3284	1·2798	27
28	2·5863	2·0889	1·8632	1·7154	1·6053	1·5175	1·4446	1·3821	1·3276	1·2791	28
29	2·5710	2·0840	1·8602	1·7133	1·6037	1·5162	1·4435	1·3812	1·3267	1·2783	29
30	2·5563	2·0792	1·8573	1·7112	1·6021	1·5149	1·4424	1·3802	1·3259	1·2775	30
31	2·5421	2·0744	1·8544	1·7091	1·6004	1·5136	1·4412	1·3792	1·3250	1·2768	31
32	2·5283	2·0696	1·8516	1·7071	1·5988	1·5123	1·4401	1·3783	1·3241	1·2760	32
33	2·5149	2·0649	1·8487	1·7050	1·5973	1·5110	1·4390	1·3773	1·3233	1·2753	33
34	2·5019	2·0603	1·8459	1·7030	1·5957	1·5097	1·4379	1·3764	1·3225	1·2745	34
35	2·4894	2·0557	1·8431	1·7010	1·5941	1·5084	1·4368	1·3754	1·3216	1·2738	35
36	2·4771	2·0512	1·8403	1·6990	1·5925	1·5071	1·4357	1·3745	1·3208	1·2730	36
37	2·4652	2·0467	1·8375	1·6970	1·5909	1·5058	1·4346	1·3735	1·3199	1·2722	37
38	2·4536	2·0422	1·8348	1·6950	1·5894	1·5045	1·4335	1·3726	1·3191	1·2715	38
39	2·4424	2·0378	1·8320	1·6930	1·5878	1·5032	1·4325	1·3716	1·3183	1·2707	39
40	2·4314	2·0334	1·8293	1·6910	1·5863	1·5019	1·4314	1·3707	1·3174	1·2700	40
41	2·4206	2·0291	1·8266	1·6890	1·5847	1·5007	1·4303	1·3697	1·3166	1·2692	41
42	2·4102	2·0248	1·8239	1·6871	1·5832	1·4994	1·4292	1·3688	1·3158	1·2685	42
43	2·4000	2·0206	1·8212	1·6851	1·5816	1·4981	1·4281	1·3678	1·3149	1·2678	43
44	2·3900	2·0164	1·8186	1·6832	1·5801	1·4969	1·4270	1·3669	1·3141	1·2670	44
45	2·3802	2·0122	1·8159	1·6812	1·5786	1·4956	1·4260	1·3660	1·3133	1·2663	45
46	2·3707	2·0081	1·8133	1·6793	1·5771	1·4943	1·4249	1·3650	1·3124	1·2655	46
47	2·3613	2·0040	1·8107	1·6774	1·5755	1·4931	1·4238	1·3641	1·3116	1·2648	47
48	2·3522	2·0000	1·8081	1·6755	1·5740	1·4918	1·4228	1·3632	1·3108	1·2640	48
49	2·3432	1·9960	1·8055	1·6736	1·5725	1·4906	1·4217	1·3622	1·3100	1·2633	49
50	2·3345	1·9920	1·8030	1·6717	1·5710	1·4894	1·4206	1·3613	1·3091	1·2626	50
51	2·3259	1·9881	1·8004	1·6698	1·5695	1·4881	1·4196	1·3604	1·3083	1·2618	51
52	2·3174	1·9842	1·7979	1·6679	1·5680	1·4869	1·4185	1·3595	1·3075	1·2611	52
53	2·3091	1·9803	1·7954	1·6661	1·5666	1·4856	1·4175	1·3586	1·3067	1·2604	53
54	2·3010	1·9765	1·7929	1·6642	1·5651	1·4844	1·4164	1·3576	1·3059	1·2596	54
55	2·2931	1·9727	1·7904	1·6624	1·5636	1·4832	1·4154	1·3567	1·3051	1·2589	55
56	2·2852	1·9690	1·7879	1·6605	1·5621	1·4820	1·4143	1·3558	1·3043	1·2582	56
57	2·2775	1·9652	1·7855	1·6587	1·5607	1·4808	1·4133	1·3549	1·3034	1·2574	57
58	2·2700	1·9615	1·7830	1·6568	1·5592	1·4795	1·4122	1·3540	1·3026	1·2567	58
59	2·2626	1·9579	1·7806	1·6550	1·5577	1·4783	1·4112	1·3531	1·3018	1·2560	59
60	2·2553	1·9542	1·7782	1·6532	1·5563	1·4771	1·4102	1·3522	1·3010	1·2553	60

PROPORTIONAL LOGARITHMS

sec. ″	h m 0° 10′	h m 0° 11′	h m 0° 12′	h m 0° 13′	h m 0° 14′	h m 0° 15′	h m 0° 16′	h m 0° 17′	h m 0° 18′	h m 0° 19′	h m 0° 20′	sec. ″
0	1·2553	1·2139	1·1761	1·1413	1·1091	1·0792	1·0512	1·0248	1·0000	9765	9542	0
1	1·2545	1·2132	1·1755	1·1408	1·1086	1·0787	1·0507	1·0244	0·9996	9761	9539	1
2	1·2538	1·2126	1·1749	1·1402	1·1081	1·0782	1·0502	1·0240	0·9992	9758	9535	2
3	1·2531	1·2119	1·1743	1·1397	1·1076	1·0777	1·0498	1·0235	0·9988	9754	9532	3
4	1·2524	1·2113	1·1737	1·1391	1·1071	1·0773	1·0493	1·0231	0·9984	9750	9528	4
5	1·2517	1·2106	1·1731	1·1385	1·1066	1·0768	1·0489	1·0227	0·9980	9746	9524	5
6	1·2510	1·2099	1·1725	1·1380	1·1061	1·0763	1·0484	1·0223	0·9976	9742	9521	6
7	1·2502	1·2093	1·1719	1·1374	1·1055	1·0758	1·0480	1·0218	0·9972	9739	9517	7
8	1·2495	1·2086	1·1713	1·1369	1·1050	1·0753	1·0475	1·0214	0·9968	9735	9514	8
9	1·2488	1·2080	1·1707	1·1363	1·1045	1·0749	1·0471	1·0210	0·9964	9731	9510	9
10	1·2481	1·2073	1·1701	1·1358	1·1040	1·0744	1·0467	1·0206	0·9960	9727	9506	10
11	1·2474	1·2067	1·1695	1·1352	1·1035	1·0739	1·0462	1·0202	0·9956	9723	9503	11
12	1·2467	1·2061	1·1689	1·1347	1·1030	1·0734	1·0458	1·0197	0·9952	9720	9499	12
13	1·2460	1·2054	1·1683	1·1341	1·1025	1·0729	1·0453	1·0193	0·9948	9716	9496	13
14	1·2453	1·2048	1·1677	1·1336	1·1020	1·0725	1·0449	1·0189	0·9944	9712	9492	14
15	1·2445	1·2041	1·1671	1·1331	1·1015	1·0720	1·0444	1·0185	0·9940	9708	9488	15
16	1·2438	1·2035	1·1665	1·1325	1·1009	1·0715	1·0440	1·0181	0·9936	9705	9485	16
17	1·2431	1·2028	1·1660	1·1320	1·1004	1·0710	1·0435	1·0176	0·9932	9701	9481	17
18	1·2424	1·2022	1·1654	1·1314	1·0999	1·0706	1·0431	1·0172	0·9928	9697	9478	18
19	1·2417	1·2015	1·1648	1·1309	1·0994	1·0701	1·0426	1·0168	0·9924	9693	9474	19
20	1·2410	1·2009	1·1642	1·1303	1·0989	1·0696	1·0422	1·0164	0·9920	9690	9471	20
21	1·2403	1·2003	1·1636	1·1298	1·0984	1·0692	1·0418	1·0160	0·9916	9686	9467	21
22	1·2396	1·1996	1·1630	1·1292	1·0979	1·0687	1·0413	1·0156	0·9912	9682	9464	22
23	1·2389	1·1990	1·1624	1·1287	1·0974	1·0682	1·0409	1·0151	0·9908	9678	9460	23
24	1·2382	1·1984	1·1619	1·1282	1·0969	1·0678	1·0404	1·0147	0·9905	9675	9456	24
25	1·2375	1·1977	1·1613	1·1276	1·0964	1·0673	1·0400	1·0143	0·9901	9671	9453	25
26	1·2368	1·1971	1·1607	1·1271	1·0959	1·0668	1·0395	1·0139	0·9897	9667	9449	26
27	1·2362	1·1965	1·1601	1·1266	1·0954	1·0663	1·0391	1·0135	0·9893	9664	9446	27
28	1·2355	1·1958	1·1595	1·1260	1·0949	1·0659	1·0387	1·0131	0·9889	9660	9442	28
29	1·2348	1·1952	1·1589	1·1255	1·0944	1·0654	1·0382	1·0126	0·9885	9656	9439	29
30	1·2341	1·1946	1·1584	1·1249	1·0939	1·0649	1·0378	1·0122	0·9881	9652	9435	30
31	1·2334	1·1939	1·1578	1·1244	1·0934	1·0645	1·0373	1·0118	0·9877	9649	9432	31
32	1·2327	1·1933	1·1572	1·1239	1·0929	1·0640	1·0369	1·0114	0·9873	9645	9428	32
33	1·2320	1·1927	1·1566	1·1233	1·0924	1·0635	1·0365	1·0110	0·9869	9641	9425	33
34	1·2313	1·1921	1·1560	1·1228	1·0919	1·0631	1·0360	1·0106	0·9865	9638	9421	34
35	1·2306	1·1914	1·1555	1·1223	1·0914	1·0626	1·0356	1·0102	0·9861	9634	9418	35
36	1·2300	1·1908	1·1549	1·1217	1·0909	1·0621	1·0352	1·0098	0·9858	9630	9414	36
37	1·2293	1·1902	1·1543	1·1212	1·0904	1·0617	1·0347	1·0093	0·9854	9626	9410	37
38	1·2286	1·1896	1·1537	1·1207	1·0899	1·0612	1·0343	1·0089	0·9850	9623	9407	38
39	1·2279	1·1889	1·1532	1·1201	1·0894	1·0608	1·0339	1·0085	0·9846	9619	9404	39
40	1·2272	1·1883	1·1526	1·1196	1·0889	1·0603	1·0334	1·0081	0·9842	9615	9400	40
41	1·2266	1·1877	1·1520	1·1191	1·0884	1·0598	1·0330	1·0077	0·9838	9612	9396	41
42	1·2259	1·1871	1·1515	1·1186	1·0880	1·0594	1·0326	1·0073	0·9834	9608	9393	42
43	1·2252	1·1865	1·1509	1·1180	1·0875	1·0589	1·0321	1·0069	0·9830	9604	9389	43
44	1·2245	1·1858	1·1503	1·1175	1·0870	1·0584	1·0317	1·0065	0·9827	9601	9386	44
45	1·2239	1·1852	1·1498	1·1170	1·0865	1·0580	1·0313	1·0061	0·9823	9597	9383	45
46	1·2232	1·1846	1·1492	1·1164	1·0860	1·0575	1·0308	1·0057	0·9819	9593	9379	46
47	1·2225	1·1840	1·1486	1·1159	1·0855	1·0571	1·0304	1·0053	0·9815	9590	9376	47
48	1·2218	1·1834	1·1481	1·1154	1·0850	1·0566	1·0300	1·0049	0·9811	9586	9372	48
49	1·2212	1·1828	1·1475	1·1149	1·0845	1·0562	1·0295	1·0044	0·9807	9582	9369	49
50	1·2205	1·1822	1·1469	1·1143	1·0840	1·0557	1·0291	1·0040	0·9803	9579	9365	50
51	1·2198	1·1816	1·1464	1·1138	1·0835	1·0552	1·0287	1·0036	0·9800	9575	9362	51
52	1·2192	1·1809	1·1458	1·1133	1·0831	1·0548	1·0282	1·0032	0·9796	9571	9358	52
53	1·2185	1·1803	1·1452	1·1128	1·0826	1·0543	1·0278	1·0028	0·9792	9568	9355	53
54	1·2178	1·1797	1·1447	1·1123	1·0821	1·0539	1·0274	1·0024	0·9788	9564	9351	54
55	1·2172	1·1791	1·1441	1·1117	1·0816	1·0534	1·0270	1·0020	0·9784	9561	9348	55
56	1·2165	1·1785	1·1436	1·1112	1·0811	1·0530	1·0265	1·0016	0·9780	9557	9344	56
57	1·2159	1·1779	1·1430	1·1107	1·0806	1·0525	1·0261	1·0012	0·9777	9553	9341	57
58	1·2152	1·1773	1·1424	1·1102	1·0801	1·0521	1·0257	1·0008	0·9773	9550	9337	58
59	1·2145	1·1767	1·1419	1·1097	1·0797	1·0516	1·0252	1·0004	0·9769	9546	9334	59
60	1·2139	1·1761	1·1413	1·1091	1·0792	1·0512	1·0248	1·0000	0·9765	9542	9331	60

PROPORTIONAL LOGARITHMS

sec. ″	h m 0° 21′	h m 0° 22′	h m 0° 23′	h m 0° 24′	h m 0° 25′	h m 0° 26′	h m 0° 27′	h m 0° 28′	h m 0° 29′	h m 0° 30′	h m 0° 31′	h m 0° 32′	sec. ″
0	9331	9128	8935	8751	8573	8403	8239	8081	7929	7782	7639	7501	0
1	9327	9125	8932	8748	8570	8400	8236	8079	7926	7779	7637	7499	1
2	9324	9122	8929	8745	8567	8397	8234	8076	7924	7777	7634	7497	2
3	9320	9119	8926	8742	8565	8395	8231	8073	7921	7774	7632	7494	3
4	9317	9115	8923	8739	8562	8392	8228	8071	7919	7772	7630	7492	4
5	9313	9112	8920	8736	8559	8389	8226	8068	7916	7769	7627	7490	5
6	9310	9109	8917	8733	8556	8386	8223	8066	7914	7767	7625	7488	6
7	9306	9105	8913	8730	8553	8383	8220	8063	7911	7765	7623	7485	7
8	9303	9102	8910	8727	8550	8381	8218	8060	7909	7762	7620	7483	8
9	9300	9099	8907	8724	8547	8378	8215	8058	7906	7760	7618	7481	9
10	9296	9096	8904	8721	8544	8375	8212	8055	7904	7757	7616	7479	10
11	9293	9092	8901	8718	8542	8372	8210	8053	7901	7755	7613	7476	11
12	9289	9089	8898	8715	8539	8370	8207	8050	7899	7753	7611	7474	12
13	9286	9086	8895	8712	8536	8367	8204	8048	7896	7750	7609	7472	13
14	9283	9083	8892	8709	8533	8364	8202	8045	7894	7748	7606	7470	14
15	9279	9079	8888	8706	8530	8361	8199	8043	7891	7745	7604	7467	15
16	9276	9076	8885	8703	8527	8359	8196	8040	7889	7743	7602	7465	16
17	9272	9073	8882	8700	8524	8356	8194	8037	7886	7741	7600	7463	17
18	9269	9070	8879	8697	8522	8353	8191	8035	7884	7738	7597	7461	18
19	9265	9066	8876	8694	8519	8350	8188	8032	7882	7736	7595	7458	19
20	9262	9063	8873	8691	8516	8348	8186	8030	7879	7734	7593	7456	20
21	9259	9060	8870	8688	8513	8345	8183	8027	7877	7731	7590	7454	21
22	9255	9057	8867	8685	8510	8342	8180	8025	7874	7729	7588	7452	22
23	9252	9053	8864	8682	8507	8339	8178	8022	7872	7726	7586	7449	23
24	9249	9050	8861	8679	8504	8337	8175	8020	7869	7724	7583	7447	24
25	9245	9047	8857	8676	8501	8334	8173	8017	7867	7722	7581	7445	25
26	9242	9044	8854	8673	8499	8331	8170	8014	7864	7719	7579	7443	26
27	9238	9041	8851	8670	8496	8328	8167	8012	7862	7717	7577	7441	27
28	9235	9037	8848	8667	8493	8326	8165	8009	7859	7714	7574	7438	28
29	9232	9034	8845	8664	8490	8323	8162	8007	7857	7712	7572	7436	29
30	9228	9031	8842	8661	8487	8320	8159	8004	7855	7710	7570	7434	30
31	9225	9028	8839	8658	8484	8317	8157	8002	7852	7707	7567	7432	31
32	9222	9024	8836	8655	8482	8315	8154	7999	7850	7705	7565	7429	32
33	9218	9021	8833	8652	8479	8312	8152	7997	7847	7703	7563	7427	33
34	9215	9018	8830	8649	8476	8309	8149	7994	7845	7700	7560	7425	34
35	9211	9015	8827	8646	8473	8307	8146	7992	7842	7698	7558	7423	35
36	9208	9012	8824	8643	8470	8304	8144	7989	7840	7696	7556	7421	36
37	9205	9008	8820	8640	8467	8301	8141	7986	7837	7693	7554	7418	37
38	9201	9005	8817	8637	8465	8298	8138	7984	7835	7691	7551	7416	38
39	9198	9002	8814	8635	8462	8296	8136	7981	7832	7688	7549	7414	39
40	9195	8999	8811	8632	8459	8293	8133	7979	7830	7686	7547	7412	40
41	9191	8996	8808	8629	8456	8290	8130	7976	7828	7684	7544	7409	41
42	9188	8992	8805	8626	8453	8288	8128	7974	7825	7681	7542	7407	42
43	9185	8989	8802	8623	8451	8285	8125	7971	7823	7679	7540	7405	43
44	9181	8986	8799	8620	8448	8282	8123	7969	7820	7677	7538	7403	44
45	9178	8983	8796	8617	8445	8279	8120	7966	7818	7674	7535	7401	45
46	9175	8980	8793	8614	8442	8277	8117	7964	7815	7672	7533	7398	46
47	9171	8977	8790	8611	8439	8274	8115	7961	7813	7670	7531	7396	47
48	9168	8973	8787	8608	8437	8271	8112	7959	7811	7667	7528	7394	48
49	9165	8970	8784	8605	8434	8269	8110	7956	7808	7665	7526	7392	49
50	9161	8967	8781	8602	8431	8266	8107	7954	7806	7662	7524	7390	50
51	9158	8964	8778	8599	8428	8263	8104	7951	7803	7660	7522	7387	51
52	9155	8961	8775	8596	8425	8261	8102	7949	7801	7658	7519	7385	52
53	9152	8957	8772	8594	8422	8258	8099	7946	7798	7655	7517	7383	53
54	9148	8954	8769	8591	8420	8255	8097	7944	7796	7653	7515	7381	54
55	9145	8951	8766	8588	8417	8252	8094	7941	7794	7651	7513	7379	55
56	9142	8948	8763	8585	8414	8250	8091	7939	7791	7648	7510	7376	56
57	9138	8945	8760	8582	8411	8247	8089	7936	7789	7646	7508	7374	57
58	9135	8942	8757	8579	8409	8244	8086	7934	7786	7644	7506	7372	58
59	9132	8939	8754	8576	8406	8242	8084	7931	7784	7641	7503	7370	59
60	9128	8935	8751	8573	8403	8239	8081	7929	7782	7639	7501	7368	60

PROPORTIONAL LOGARITHMS

sec. ″	h m 0° 33′	h m 0° 34′	h m 0° 35′	h m 0° 36′	h m 0° 37′	h m 0° 38′	h m 0° 39′	h m 0° 40′	h m 0° 41′	h m 0° 42′	h m 0° 43′	h m 0° 44′	sec ″
0	7368	7238	7112	6990	6871	6755	6642	6532	6425	6320	6218	6118	0
1	7365	7236	7110	6988	6869	6753	6640	6530	6423	6318	6216	6117	1
2	7363	7234	7108	6986	6867	6751	6638	6528	6421	6317	6215	6115	2
3	7361	7232	7106	6984	6865	6749	6637	6527	6420	6315	6213	6113	3
4	7359	7229	7104	6982	6863	6747	6635	6525	6418	6313	6211	6112	4
5	7357	7227	7102	6980	6861	6745	6633	6523	6416	6312	6210	6110	5
6	7354	7225	7100	6978	6859	6743	6631	6521	6414	6310	6208	6108	6
7	7352	7223	7098	6976	6857	6742	6629	6519	6412	6308	6206	6107	7
8	7350	7221	7095	6974	6855	6740	6627	6518	6411	6306	6205	6105	8
9	7348	7219	7093	6972	6853	6738	6625	6516	6409	6305	6203	6103	9
10	7346	7217	7091	6970	6851	6736	6624	6514	6407	6303	6201	6102	10
11	7343	7215	7089	6968	6849	6734	6622	6512	6405	6301	6200	6100	11
12	7341	7212	7087	6966	6847	6732	6620	6510	6404	6300	6198	6099	12
13	7339	7210	7085	6964	6845	6730	6618	6509	6402	6298	6196	6097	13
14	7337	7208	7083	6962	6843	6728	6616	6507	6400	6296	6194	6095	14
15	7335	7206	7081	6960	6841	6726	6614	6505	6398	6294	6193	6094	15
16	7333	7204	7079	6958	6839	6724	6612	6503	6397	6293	6191	6092	16
17	7330	7202	7077	6956	6838	6723	6611	6501	6395	6291	6189	6090	17
18	7328	7200	7075	6954	6836	6721	6609	6500	6393	6289	6188	6089	18
19	7326	7198	7073	6952	6834	6719	6607	6498	6391	6288	6186	6087	19
20	7324	7196	7071	6950	6832	6717	6605	6496	6390	6286	6184	6085	20
21	7322	7193	7069	6948	6830	6715	6603	6494	6388	6284	6183	6084	21
22	7320	7191	7067	6946	6828	6713	6601	6492	6386	6282	6181	6082	22
23	7317	7189	7065	6944	6826	6711	6600	6491	6384	6281	6179	6080	23
24	7315	7187	7063	6942	6824	6709	6598	6489	6383	6279	6178	6079	24
25	7313	7185	7061	6940	6822	6707	6596	6487	6381	6277	6176	6077	25
26	7311	7183	7059	6938	6820	6706	6594	6485	6379	6276	6174	6076	26
27	7309	7181	7057	6936	6818	6704	6592	6484	6377	6274	6173	6074	27
28	7307	7179	7054	6934	6816	6702	6590	6482	6376	6272	6171	6072	28
29	7304	7177	7052	6932	6814	6700	6589	6480	6374	6270	6169	6071	29
30	7302	7175	7050	6930	6812	6698	6587	6478	6372	6269	6168	6069	30
31	7300	7172	7048	6928	6810	6696	6585	6476	6370	6267	6166	6067	31
32	7298	7170	7046	6926	6809	6694	6583	6475	6369	6265	6164	6066	32
33	7296	7168	7044	6924	6807	6692	6581	6473	6367	6264	6163	6064	33
34	7294	7166	7042	6922	6805	6691	6579	6471	6365	6262	6161	6063	34
35	7291	7164	7040	6920	6803	6689	6578	6469	6363	6260	6159	6061	35
36	7289	7162	7038	6918	6801	6687	6576	6467	6362	6259	6158	6059	36
37	7287	7160	7036	6916	6799	6685	6574	6466	6360	6257	6156	6058	37
38	7285	7158	7034	6914	6797	6683	6572	6464	6358	6255	6154	6056	38
39	7283	7156	7032	6912	6795	6681	6570	6462	6357	6254	6153	6055	39
40	7281	7154	7030	6910	6793	6679	6568	6460	6355	6252	6151	6053	40
41	7279	7152	7028	6908	6791	6677	6567	6459	6353	6250	6150	6051	41
42	7276	7149	7026	6906	6789	6676	6565	6457	6351	6248	6148	6050	42
43	7274	7147	7024	6904	6787	6674	6563	6455	6350	6247	6146	6048	43
44	7272	7145	7022	6902	6785	6672	6561	6453	6348	6245	6145	6046	44
45	7270	7143	7020	6900	6784	6670	6559	6451	6346	6243	6143	6045	45
46	7268	7141	7018	6898	6782	6668	6557	6450	6344	6242	6141	6043	46
47	7266	7139	7016	6896	6780	6666	6556	6448	6343	6240	6140	6042	47
48	7264	7137	7014	6894	6778	6664	6554	6446	6341	6238	6138	6040	48
49	7261	7135	7012	6892	6776	6662	6552	6444	6339	6237	6136	6038	49
50	7259	7133	7010	6890	6774	6661	6550	6443	6338	6235	6135	6037	50
51	7257	7131	7008	6888	6772	6659	6548	6441	6336	6233	6133	6035	51
52	7255	7129	7006	6886	6770	6657	6547	6439	6334	6231	6131	6033	52
53	7253	7126	7004	6884	6768	6655	6545	6437	6332	6230	6130	6032	53
54	7251	7124	7002	6882	6766	6653	6543	6435	6331	6228	6128	6030	54
55	7249	7122	7000	6880	6764	6651	6541	6434	6329	6226	6126	6029	55
56	7246	7120	6998	6878	6762	6649	6539	6432	6327	6225	6125	6027	56
57	7244	7118	6996	6877	6761	6648	6538	6430	6325	6223	6123	6025	57
58	7242	7116	6994	6875	6759	6646	6536	6428	6324	6221	6121	6024	58
59	7240	7114	6992	6873	6757	6644	6534	6427	6322	6220	6120	6022	59
60	7238	7112	6990	6871	6755	6642	6532	6425	6320	6218	6118	6021	60

PROPORTIONAL LOGARITHMS

sec. ″	0h 45m	0h 46m	0h 47m	0h 48m	0h 49m	0h 50m	0h 51m	0h 52m	0h 53m	0h 54m	0h 55m	0h 56m	sec. ″
0	6021	5925	5832	5740	5651	5563	5477	5393	5310	5229	5149	5071	0
1	6019	5924	5830	5739	5649	5562	5476	5391	5309	5227	5148	5070	1
2	6017	5922	5829	5737	5648	5560	5474	5390	5307	5226	5146	5068	2
3	6016	5920	5827	5736	5646	5559	5473	5389	5306	5225	5145	5067	3
4	6014	5919	5826	5734	5645	5557	5471	5387	5304	5223	5144	5066	4
5	6013	5917	5824	5733	5643	5556	5470	5386	5303	5222	5142	5064	5
6	6011	5916	5823	5731	5642	5554	5469	5384	5302	5221	5141	5063	6
7	6009	5914	5821	5730	5640	5553	5467	5383	5300	5219	5140	5062	7
8	6008	5913	5819	5728	5639	5551	5466	5382	5299	5218	5139	5060	8
9	6006	5911	5818	5727	5637	5550	5464	5380	5298	5217	5137	5059	9
10	6004	5909	5816	5725	5636	5549	5463	5379	5296	5215	5136	5058	10
11	6003	5908	5815	5724	5634	5547	5461	5377	5295	5214	5135	5057	11
12	6001	5906	5813	5722	5633	5546	5460	5376	5294	5213	5133	5055	12
13	6000	5905	5812	5721	5632	5544	5459	5375	5292	5211	5132	5054	13
14	5998	5903	5810	5719	5630	5543	5457	5373	5291	5210	5131	5053	14
15	5997	5902	5809	5718	5629	5541	5456	5372	5290	5209	5129	5051	15
16	5995	5900	5807	5716	5627	5540	5454	5370	5288	5207	5128	5050	16
17	5993	5898	5806	5715	5626	5538	5453	5369	5287	5206	5127	5049	17
18	5992	5897	5804	5713	5624	5537	5452	5368	5285	5205	5125	5048	18
19	5990	5895	5803	5712	5623	5536	5450	5366	5284	5203	5124	5046	19
20	5988	5894	5801	5710	5621	5534	5449	5365	5283	5202	5123	5045	20
21	5987	5892	5800	5709	5620	5533	5447	5364	5281	5201	5122	5044	21
22	5985	5891	5798	5707	5618	5531	5446	5362	5280	5199	5120	5042	22
23	5984	5889	5796	5706	5617	5530	5444	5361	5279	5198	5119	5041	23
24	5982	5888	5795	5704	5615	5528	5443	5359	5277	5197	5118	5040	24
25	5981	5886	5793	5703	5614	5527	5442	5358	5276	5195	5116	5039	25
26	5979	5884	5792	5701	5612	5525	5440	5357	5275	5194	5115	5037	26
27	5977	5883	5790	5700	5611	5524	5439	5355	5273	5193	5114	5036	27
28	5976	5881	5789	5698	5610	5523	5437	5354	5272	5191	5112	5035	28
29	5974	5880	5787	5697	5608	5521	5436	5352	5270	5190	5111	5033	29
30	5973	5878	5786	5695	5607	5520	5435	5351	5269	5189	5110	5032	30
31	5971	5877	5784	5694	5605	5518	5433	5350	5268	5187	5108	5031	31
32	5969	5875	5783	5692	5604	5517	5432	5348	5266	5186	5107	5030	32
33	5968	5874	5781	5691	5602	5516	5430	5347	5265	5185	5106	5028	33
34	5966	5872	5780	5689	5601	5514	5429	5346	5264	5183	5105	5027	34
35	5965	5870	5778	5688	5599	5513	5428	5344	5262	5182	5103	5026	35
36	5963	5869	5777	5686	5598	5511	5426	5343	5261	5181	5102	5025	36
37	5961	5867	5775	5685	5596	5510	5425	5341	5260	5179	5101	5023	37
38	5960	5866	5774	5683	5595	5508	5423	5340	5258	5178	5099	5022	38
39	5958	5864	5772	5682	5594	5507	5422	5339	5257	5177	5098	5021	39
40	5957	5863	5771	5680	5592	5505	5421	5337	5256	5175	5097	5019	40
41	5955	5861	5769	5679	5591	5504	5419	5336	5254	5174	5095	5018	41
42	5954	5860	5768	5677	5589	5503	5418	5335	5253	5173	5094	5017	42
43	5952	5858	5766	5676	5588	5501	5416	5333	5252	5171	5093	5016	43
44	5950	5856	5764	5674	5586	5500	5415	5332	5250	5170	5092	5014	44
45	5949	5855	5763	5673	5585	5498	5414	5331	5249	5169	5090	5013	45
46	5947	5853	5761	5671	5583	5497	5412	5329	5248	5168	5089	5012	46
47	5946	5852	5760	5670	5582	5495	5411	5328	5246	5166	5088	5010	47
48	5944	5850	5758	5669	5580	5494	5409	5326	5245	5165	5086	5009	48
49	5942	5849	5757	5667	5579	5493	5408	5325	5244	5164	5085	5008	49
50	5941	5847	5755	5666	5577	5491	5407	5324	5242	5162	5084	5007	50
51	5939	5846	5754	5664	5576	5490	5405	5322	5241	5161	5082	5005	51
52	5938	5844	5752	5663	5575	5488	5404	5321	5239	5160	5081	5004	52
53	5936	5842	5751	5661	5573	5487	5402	5319	5238	5158	5080	5003	53
54	5935	5841	5749	5660	5572	5486	5401	5318	5237	5157	5079	5002	54
55	5933	5839	5748	5658	5570	5484	5400	5317	5235	5156	5077	5000	55
56	5931	5838	5746	5657	5569	5483	5398	5315	5234	5154	5076	4999	56
57	5930	5836	5745	5655	5567	5481	5397	5314	5233	5153	5075	4998	57
58	5928	5835	5743	5654	5566	5480	5395	5313	5231	5152	5073	4996	58
59	5927	5833	5742	5652	5564	5478	5394	5311	5230	5150	5072	4995	59
60	5925	5832	5740	5651	5563	5477	5394	5310	5229	5149	5071	4994	60

PROPORTIONAL LOGARITHMS

sec. ″	h m 0° 57′	h m 0° 58′	h m 0° 59′	h m 1° 0′	h m 1° 1′	h m 1° 2′	h m 1° 3′	h m 1° 4′	h m 1° 5′	h m 1° 6′	h m 1° 7′	h m 1° 8′	h m 1° 9′	sec. ″
0	4994	4918	4844	4771	4699	4629	4559	4491	4424	4357	4292	4228	4164	0
1	4993	4917	4843	4770	4698	4628	4558	4490	4422	4356	4291	4227	4163	1
2	4991	4916	4842	4769	4697	4626	4557	4489	4421	4355	4290	4225	4162	2
3	4990	4915	4841	4768	4696	4625	4556	4488	4420	4354	4289	4224	4161	3
4	4989	4913	4839	4766	4694	4624	4555	4486	4419	4353	4288	4223	4160	4
5	4988	4912	4838	4765	4693	4623	4554	4485	4418	4352	4287	4222	4159	5
6	4986	4911	4837	4764	4692	4622	4552	4484	4417	4351	4285	4221	4158	6
7	4985	4910	4836	4763	4691	4621	4551	4483	4416	4350	4284	4220	4157	7
8	4984	4908	4834	4762	4690	4619	4550	4482	4415	4348	4283	4219	4156	8
9	4983	4907	4833	4760	4689	4618	4549	4481	4414	4347	4282	4218	4155	9
10	4981	4906	4832	4759	4688	4617	4548	4480	4412	4346	4281	4217	4154	10
11	4980	4905	4831	4758	4686	4616	4547	4478	4411	4345	4280	4216	4153	11
12	4979	4903	4830	4757	4685	4615	4546	4477	4410	4344	4279	4215	4152	12
13	4977	4902	4828	4756	4684	4614	4544	4476	4409	4343	4278	4214	4151	13
14	4976	4901	4827	4754	4683	4612	4543	4475	4408	4342	4277	4213	4150	14
15	4975	4900	4826	4753	4682	4611	4542	4474	4407	4341	4276	4212	4149	15
16	4974	4898	4825	4752	4680	4610	4541	4473	4406	4340	4275	4211	4147	16
17	4972	4897	4823	4751	4679	4609	4540	4472	4405	4339	4274	4210	4146	17
18	4971	4896	4822	4750	4678	4608	4539	4471	4404	4338	4273	4209	4145	18
19	4970	4895	4821	4748	4677	4607	4537	4469	4402	4336	4271	4207	4144	19
20	4969	4894	4820	4747	4676	4605	4536	4468	4401	4335	4270	4206	4143	20
21	4967	4892	4819	4746	4675	4604	4535	4467	4400	4334	4269	4205	4142	21
22	4966	4891	4817	4745	4673	4603	4534	4466	4399	4333	4268	4204	4141	22
23	4965	4890	4816	4744	4672	4602	4533	4465	4398	4332	4267	4203	4140	23
24	4964	4889	4815	4742	4671	4601	4532	4464	4397	4331	4266	4202	4139	24
25	4962	4887	4814	4741	4670	4600	4531	4463	4396	4330	4265	4201	4138	25
26	4961	4886	4812	4740	4669	4599	4529	4462	4395	4329	4264	4200	4137	26
27	4960	4885	4811	4739	4668	4597	4528	4460	4394	4328	4263	4199	4136	27
28	4959	4884	4810	4738	4666	4596	4527	4459	4392	4327	4262	4198	4135	28
29	4957	4882	4809	4736	4665	4595	4526	4458	4391	4326	4261	4197	4134	29
30	4956	4881	4808	4735	4664	4594	4525	4457	4390	4325	4260	4196	4133	30
31	4955	4880	4806	4734	4663	4593	4524	4456	4389	4323	4259	4195	4132	31
32	4953	4879	4805	4733	4662	4592	4523	4455	4388	4322	4257	4194	4131	32
33	4952	4877	4804	4732	4660	4590	4522	4454	4387	4321	4256	4193	4130	33
34	4951	4876	4803	4730	4659	4589	4520	4453	4386	4320	4255	4192	4129	34
35	4950	4875	4801	4729	4658	4588	4519	4451	4385	4319	4254	4190	4128	35
36	4949	4874	4800	4728	4657	4587	4518	4450	4384	4318	4253	4189	4127	36
37	4947	4872	4799	4727	4656	4586	4517	4449	4383	4317	4252	4188	4126	37
38	4946	4871	4798	4726	4655	4585	4516	4448	4381	4316	4251	4187	4125	38
39	4945	4870	4797	4724	4653	4584	4515	4447	4380	4315	4250	4186	4124	39
40	4943	4869	4795	4723	4652	4582	4514	4446	4379	4314	4249	4185	4122	40
41	4942	4868	4794	4722	4651	4581	4512	4445	4378	4313	4248	4184	4121	41
42	4941	4866	4793	4721	4650	4580	4511	4444	4377	4311	4247	4183	4120	42
43	4940	4865	4792	4720	4649	4579	4510	4443	4376	4310	4246	4182	4119	43
44	4938	4864	4791	4718	4647	4578	4509	4441	4375	4309	4245	4181	4118	44
45	4937	4863	4789	4717	4646	4577	4508	4440	4374	4308	4244	4180	4117	45
46	4936	4861	4788	4716	4645	4575	4507	4439	4373	4307	4243	4179	4116	46
47	4935	4860	4787	4715	4644	4574	4506	4438	4372	4306	4241	4178	4115	47
48	4933	4859	4786	4714	4643	4573	4505	4437	4370	4305	4240	4177	4114	48
49	4932	4858	4784	4712	4642	4572	4503	4436	4369	4304	4239	4176	4113	49
50	4931	4856	4783	4711	4640	4571	4502	4435	4368	4303	4238	4175	4112	50
51	4930	4855	4782	4710	4639	4570	4501	4434	4367	4302	4237	4174	4111	51
52	4928	4854	4781	4709	4638	4568	4500	4432	4366	4301	4236	4173	4110	52
53	4927	4853	4780	4708	4637	4567	4499	4431	4365	4299	4235	4172	4109	53
54	4926	4852	4778	4707	4636	4566	4498	4430	4364	4298	4234	4171	4108	54
55	4925	4850	4777	4705	4635	4565	4497	4429	4363	4297	4233	4169	4107	55
56	4923	4849	4776	4704	4633	4564	4495	4428	4362	4296	4232	4168	4106	56
57	4922	4848	4775	4703	4632	4563	4494	4427	4361	4295	4231	4167	4105	57
58	4921	4846	4774	4702	4631	4562	4493	4426	4359	4294	4230	4166	4104	58
59	4920	4845	4772	4701	4630	4560	4492	4425	4358	4293	4229	4165	4103	59
60	4918	4844	4771	4699	4629	4559	4491	4424	4357	4292	4228	4164	4102	60

PROPORTIONAL LOGARITHMS

sec. ″	1h 10m	1h 11m	1h 12m	1h 13m	1h 14m	1h 15m	1h 16m	1h 17m	1h 18m	1h 19m	1h 20m	1h 21m	sec. ″
0	4102	4040	3979	3919	3860	3802	3745	3688	3632	3576	3522	3468	0
1	4101	4039	3978	3918	3859	3801	3744	3687	3631	3575	3521	3467	1
2	4100	4038	3977	3917	3858	3800	3743	3686	3630	3575	3520	3466	2
3	4099	4037	3976	3917	3857	3799	3742	3685	3629	3574	3519	3465	3
4	4098	4036	3975	3916	3856	3798	3741	3684	3628	3573	3518	3464	4
5	4097	4035	3974	3915	3855	3797	3740	3683	3627	3572	3517	3463	5
6	4096	4034	3973	3914	3855	3796	3739	3682	3626	3571	3516	3463	6
7	4094	4033	3972	3913	3854	3795	3738	3681	3625	3570	3515	3462	7
8	4093	4032	3971	3912	3853	3794	3737	3680	3624	3569	3515	3461	8
9	4092	4031	3970	3911	3852	3793	3736	3679	3623	3568	3514	3460	9
10	4091	4030	3969	3910	3851	3792	3735	3678	3622	3567	3513	3459	10
11	4090	4029	3968	3909	3850	3791	3734	3677	3622	3566	3512	3458	11
12	4089	4028	3967	3908	3849	3791	3733	3677	3621	3565	3511	3457	12
13	4088	4027	3966	3907	3848	3790	3732	3676	3620	3565	3510	3456	13
14	4087	4026	3965	3906	3847	3789	3731	3675	3619	3564	3509	3455	14
15	4086	4025	3964	3905	3846	3788	3730	3674	3618	3563	3508	3454	15
16	4085	4024	3963	3904	3845	3787	3729	3673	3617	3562	3507	3454	16
17	4084	4023	3962	3903	3844	3786	3728	3672	3616	3561	3506	3453	17
18	4083	4022	3961	3902	3843	3785	3727	3671	3615	3560	3506	3452	18
19	4082	4021	3960	3901	3842	3784	3726	3670	3614	3559	3505	3451	19
20	4081	4020	3959	3900	3841	3783	3726	3669	3613	3558	3504	3450	20
21	4080	4019	3958	3899	3840	3782	3725	3668	3612	3557	3503	3449	21
22	4079	4018	3957	3898	3839	3781	3724	3667	3611	3556	3502	3448	22
23	4078	4017	3956	3897	3838	3780	3723	3666	3610	3555	3501	3447	23
24	4077	4016	3955	3896	3837	3779	3722	3665	3610	3555	3500	3446	24
25	4076	4015	3954	3895	3836	3778	3721	3664	3609	3554	3499	3446	25
26	4075	4014	3953	3894	3835	3777	3720	3663	3608	3553	3498	3445	26
27	4074	4013	3952	3893	3834	3776	3719	3663	3607	3552	3497	3444	27
28	4073	4012	3951	3892	3833	3775	3718	3662	3606	3551	3496	3443	28
29	4072	4011	3950	3891	3832	3774	3717	3661	3605	3550	3496	3442	29
30	4071	4010	3949	3890	3831	3773	3716	3660	3604	3549	3495	3441	30
31	4070	4009	3948	3889	3830	3772	3715	3659	3603	3548	3494	3440	31
32	4069	4008	3947	3888	3829	3771	3714	3658	3602	3547	3493	3439	32
33	4068	4007	3946	3887	3828	3770	3713	3657	3601	3546	3492	3438	33
34	4067	4006	3945	3886	3827	3769	3712	3656	3600	3545	3491	3438	34
35	4066	4005	3944	3885	3826	3768	3711	3655	3599	3544	3490	3437	35
36	4065	4004	3943	3884	3825	3768	3710	3654	3598	3544	3489	3436	36
37	4064	4003	3942	3883	3824	3767	3709	3653	3598	3543	3488	3435	37
38	4063	4002	3941	3882	3823	3766	3708	3652	3597	3542	3488	3434	38
39	4062	4001	3940	3881	3822	3765	3708	3651	3596	3541	3487	3433	39
40	4061	4000	3939	3880	3821	3764	3707	3650	3595	3540	3486	3432	40
41	4060	3999	3938	3879	3820	3763	3706	3649	3594	3539	3485	3431	41
42	4059	3998	3937	3878	3820	3762	3705	3649	3593	3538	3484	3431	42
43	4057	3997	3936	3877	3819	3761	3704	3648	3592	3537	3483	3430	43
44	4056	3996	3935	3876	3818	3760	3703	3647	3591	3536	3482	3429	44
45	4055	3995	3934	3875	3817	3759	3702	3646	3590	3535	3481	3428	45
46	4054	3993	3933	3874	3816	3758	3701	3645	3589	3534	3480	3427	46
47	4053	3992	3932	3873	3815	3757	3700	3644	3588	3533	3479	3426	47
48	4052	3991	3931	3872	3814	3756	3699	3643	3587	3533	3479	3425	48
49	4051	3990	3930	3871	3813	3755	3698	3642	3586	3532	3478	3424	49
50	4050	3989	3929	3870	3812	3754	3697	3641	3586	3531	3477	3423	50
51	4049	3988	3928	3869	3811	3753	3696	3640	3585	3530	3476	3423	51
52	4048	3987	3927	3868	3810	3752	3695	3639	3584	3529	3475	3422	52
53	4047	3986	3926	3867	3809	3751	3694	3638	3583	3528	3474	3421	53
54	4046	3985	3925	3866	3808	3750	3693	3637	3582	3527	3473	3420	54
55	4045	3984	3924	3865	3807	3749	3692	3636	3581	3526	3472	3419	55
56	4044	3983	3923	3864	3806	3748	3692	3635	3580	3525	3471	3418	56
57	4043	3982	3922	3863	3805	3747	3691	3635	3579	3525	3471	3417	57
58	4042	3981	3921	3862	3804	3746	3690	3634	3578	3524	3470	3416	58
59	4041	3980	3920	3861	3803	3745	3689	3633	3577	3523	3469	3415	59
60	4040	3979	3919	3860	3802	3745	3688	3632	3576	3522	3468	3415	60

PROPORTIONAL LOGARITHMS

sec. ″	h m 1° 22′	h m 1° 23′	h m 1° 24′	h m 1° 25′	h m 1° 26′	h m 1° 27′	h m 1° 28′	h m 1° 29′	h m 1° 30′	h m 1° 31′	h m 1° 32′	h m 1° 33′	sec. ″
0	3415	3362	3310	3259	3208	3158	3108	3059	3010	2962	2915	2868	0
1	3414	3361	3309	3258	3207	3157	3107	3058	3009	2961	2914	2867	1
2	3413	3360	3308	3257	3206	3156	3106	3057	3009	2961	2913	2866	2
3	3412	3359	3307	3256	3205	3155	3105	3056	3008	2960	2912	2866	3
4	3411	3358	3306	3255	3204	3154	3105	3056	3007	2959	2912	2865	4
5	3410	3358	3306	3254	3203	3153	3104	3055	3006	2958	2911	2864	5
6	3409	3357	3305	3253	3203	3153	3103	3054	3005	2958	2910	2863	6
7	3408	3356	3304	3253	3202	3152	3102	3053	3005	2957	2909	2862	7
8	3407	3355	3303	3252	3201	3151	3101	3052	3004	2956	2909	2862	8
9	3407	3354	3302	3251	3200	3150	3101	3052	3003	2955	2908	2861	9
10	3406	3353	3301	3250	3199	3149	3100	3051	3002	2954	2907	2860	10
11	3405	3352	3300	3249	3198	3148	3099	3050	3001	2954	2906	2859	11
12	3404	3351	3300	3248	3198	3148	3098	3049	3001	2953	2905	2859	12
13	3403	3351	3299	3247	3197	3147	3097	3048	3000	2952	2905	2858	13
14	3402	3350	3298	3247	3196	3146	3097	3047	2999	2951	2904	2857	14
15	3401	3349	3297	3246	3195	3145	3096	3047	2998	2950	2903	2856	15
16	3400	3348	3296	3245	3194	3144	3095	3046	2997	2950	2902	2855	16
17	3400	3347	3295	3244	3193	3143	3094	3045	2997	2949	2901	2855	17
18	3399	3346	3294	3243	3193	3143	3093	3044	2996	2948	2901	2854	18
19	3398	3345	3294	3242	3192	3142	3092	3043	2995	2947	2900	2853	19
20	3397	3344	3293	3241	3191	3141	3091	3043	2994	2946	2899	2852	20
21	3396	3344	3292	3241	3190	3140	3091	3042	2993	2946	2898	2852	21
22	3395	3343	3291	3240	3189	3139	3090	3041	2993	2945	2898	2851	22
23	3394	3342	3290	3239	3188	3138	3089	3040	2992	2944	2897	2850	23
24	3393	3341	3289	3238	3188	3138	3088	3039	2991	2943	2896	2849	24
25	3393	3340	3288	3237	3187	3137	3087	3038	2990	2942	2895	2848	25
26	3392	3339	3288	3236	3186	3136	3087	3038	2989	2942	2894	2848	26
27	3391	3338	3287	3236	3185	3135	3086	3037	2989	2941	2894	2847	27
28	3390	3338	3286	3235	3184	3134	3085	3036	2988	2940	2893	2846	28
29	3389	3337	3285	3234	3183	3133	3084	3035	2987	2939	2892	2845	29
30	3388	3336	3284	3233	3183	3133	3083	3034	2986	2939	2891	2845	30
31	3387	3335	3283	3232	3182	3132	3082	3034	2985	2938	2890	2844	31
32	3386	3334	3282	3231	3181	3131	3082	3033	2985	2937	2890	2843	32
33	3386	3333	3282	3231	3180	3130	3081	3032	2984	2936	2889	2842	33
34	3385	3332	3281	3230	3179	3129	3080	3031	2983	2935	2888	2841	34
35	3384	3331	3280	3229	3178	3128	3079	3030	2982	2935	2887	2841	35
36	3383	3331	3279	3228	3178	3128	3078	3030	2981	2934	2887	2840	36
37	3382	3330	3278	3227	3177	3127	3078	3029	2981	2933	2886	2839	37
38	3381	3329	3277	3226	3176	3126	3077	3028	2980	2932	2885	2838	38
39	3380	3328	3276	3225	3175	3125	3076	3027	2979	2931	2884	2838	39
40	3379	3327	3276	3225	3174	3124	3075	3026	2978	2931	2883	2837	40
41	3378	3326	3275	3224	3173	3124	3074	3026	2977	2930	2883	2836	41
42	3378	3325	3274	3223	3173	3123	3073	3025	2977	2929	2882	2835	42
43	3377	3325	3273	3222	3172	3122	3073	3024	2976	2928	2881	2835	43
44	3376	3324	3272	3221	3171	3121	3072	3023	2975	2927	2880	2834	44
45	3375	3323	3271	3220	3170	3120	3071	3022	2974	2927	2880	2833	45
46	3374	3322	3270	3219	3169	3119	3070	3022	2973	2926	2879	2832	46
47	3373	3321	3270	3219	3168	3119	3069	3021	2973	2925	2878	2831	47
48	3372	3320	3269	3218	3168	3118	3069	3020	2972	2924	2877	2831	48
49	3371	3319	3268	3217	3167	3117	3068	3019	2971	2923	2876	2830	49
50	3371	3319	3267	3216	3166	3116	3067	3018	2970	2923	2876	2829	50
51	3370	3318	3266	3215	3165	3115	3066	3018	2969	2922	2875	2828	51
52	3369	3317	3265	3214	3164	3114	3065	3017	2969	2921	2874	2828	52
53	3368	3316	3264	3214	3163	3114	3064	3016	2968	2920	2873	2827	53
54	3367	3315	3264	3213	3163	3113	3064	3015	2967	2920	2873	2826	54
55	3366	3314	3263	3212	3162	3112	3063	3014	2966	2919	2872	2825	55
56	3365	3313	3262	3211	3161	3111	3062	3013	2965	2918	2871	2824	56
57	3365	3313	3261	3210	3160	3110	3061	3013	2965	2917	2870	2824	57
58	3364	3312	3260	3209	3159	3109	3060	3012	2964	2916	2869	2823	58
59	3363	3311	3259	3209	3158	3109	3060	3011	2963	2916	2869	2822	59
60	3362	3310	3259	3208	3158	3108	3059	3010	2962	2915	2868	2821	60

PROPORTIONAL LOGARITHMS

sec. ″	h m 1° 34′	h m 1° 35′	h m 1° 36′	h m 1° 37′	h m 1° 38′	h m 1° 39′	h m 1° 40′	h m 1° 41′	h m 1° 42′	h m 1° 43′	h m 1° 44′	h m 1° 45′	sec. ″
0	2821	2775	2730	2685	2640	2596	2553	2510	2467	2424	2382	2341	0
1	2821	2775	2729	2684	2640	2596	2552	2509	2466	2424	2382	2340	1
2	2820	2774	2728	2683	2639	2595	2551	2508	2465	2423	2381	2339	2
3	2819	2773	2728	2683	2638	2594	2551	2507	2465	2422	2380	2339	3
4	2818	2772	2727	2682	2637	2593	2550	2507	2464	2421	2380	2338	4
5	2818	2772	2726	2681	2637	2593	2549	2506	2463	2421	2379	2337	5
6	2817	2771	2725	2681	2636	2592	2548	2505	2462	2420	2378	2337	6
7	2816	2770	2725	2680	2635	2591	2548	2504	2462	2419	2378	2336	7
8	2815	2769	2724	2679	2634	2590	2547	2504	2461	2419	2377	2335	8
9	2815	2769	2723	2678	2634	2590	2546	2503	2460	2418	2376	2335	9
10	2814	2768	2722	2678	2633	2589	2545	2502	2460	2417	2375	2334	10
11	2813	2767	2722	2677	2632	2588	2545	2502	2459	2417	2375	2333	11
12	2812	2766	2721	2676	2632	2588	2544	2501	2458	2416	2374	2333	12
13	2811	2766	2720	2675	2631	2587	2543	2500	2457	2415	2373	2332	13
14	2811	2765	2719	2675	2630	2586	2543	2499	2457	2414	2373	2331	14
15	2810	2764	2719	2674	2629	2585	2542	2499	2456	2414	2372	2331	15
16	2809	2763	2718	2673	2629	2585	2541	2498	2455	2413	2371	2330	16
17	2808	2763	2717	2672	2628	2584	2540	2497	2455	2412	2371	2329	17
18	2808	2762	2716	2672	2627	2583	2540	2497	2454	2412	2370	2328	18
19	2807	2761	2716	2671	2626	2582	2539	2496	2453	2411	2369	2328	19
20	2806	2760	2715	2670	2626	2582	2538	2495	2453	2410	2368	2327	20
21	2805	2760	2714	2669	2625	2581	2538	2494	2452	2410	2368	2326	21
22	2804	2759	2713	2669	2624	2580	2537	2494	2451	2409	2367	2326	22
23	2804	2758	2713	2668	2623	2580	2536	2493	2450	2408	2366	2325	23
24	2803	2757	2712	2667	2623	2579	2535	2492	2450	2408	2366	2324	24
25	2802	2756	2711	2666	2622	2578	2535	2492	2449	2407	2365	2324	25
26	2801	2756	2710	2666	2621	2577	2534	2491	2448	2406	2364	2323	26
27	2801	2755	2710	2665	2621	2577	2533	2490	2448	2405	2364	2322	27
28	2800	2754	2709	2664	2620	2576	2532	2489	2447	2405	2363	2322	28
29	2799	2753	2708	2663	2619	2575	2532	2489	2446	2404	2362	2321	29
30	2798	2753	2707	2663	2618	2574	2531	2488	2445	2403	2362	2320	30
31	2798	2752	2707	2662	2618	2574	2530	2487	2445	2403	2361	2319	31
32	2797	2751	2706	2661	2617	2573	2530	2487	2444	2402	2360	2319	32
33	2796	2750	2705	2660	2616	2572	2529	2486	2443	2401	2359	2318	33
34	2795	2750	2704	2660	2615	2572	2528	2485	2443	2400	2359	2317	34
35	2795	2749	2704	2659	2615	2571	2527	2484	2442	2400	2358	2317	35
36	2794	2748	2703	2658	2614	2570	2527	2484	2441	2399	2357	2316	36
37	2793	2747	2702	2657	2613	2569	2526	2483	2440	2398	2357	2315	37
38	2792	2747	2701	2657	2612	2569	2525	2482	2440	2398	2356	2315	38
39	2792	2746	2701	2656	2612	2568	2525	2482	2439	2397	2355	2314	39
40	2791	2745	2700	2655	2611	2567	2524	2481	2438	2396	2355	2313	40
41	2790	2744	2699	2654	2610	2566	2523	2480	2438	2396	2354	2313	41
42	2789	2744	2698	2654	2610	2566	2522	2480	2437	2395	2353	2312	42
43	2788	2743	2698	2653	2609	2565	2522	2479	2436	2394	2353	2311	43
44	2788	2742	2697	2652	2608	2564	2521	2478	2436	2394	2352	2311	44
45	2787	2741	2696	2652	2607	2564	2520	2477	2435	2393	2351	2310	45
46	2786	2741	2695	2651	2607	2563	2520	2477	2434	2392	2350	2309	46
47	2785	2740	2695	2650	2606	2562	2519	2476	2433	2391	2350	2308	47
48	2785	2739	2694	2649	2605	2561	2518	2475	2433	2391	2349	2308	48
49	2784	2738	2693	2649	2604	2561	2517	2474	2432	2390	2348	2307	49
50	2783	2738	2692	2648	2604	2560	2517	2474	2431	2389	2348	2306	50
51	2782	2737	2692	2647	2603	2559	2516	2473	2431	2389	2347	2306	51
52	2782	2736	2691	2646	2602	2558	2515	2472	2430	2388	2346	2305	52
53	2781	2735	2690	2646	2601	2558	2514	2472	2429	2387	2346	2304	53
54	2780	2735	2689	2645	2601	2557	2514	2471	2429	2387	2345	2304	54
55	2779	2734	2689	2644	2600	2556	2513	2470	2428	2386	2344	2303	55
56	2778	2733	2688	2643	2599	2556	2512	2470	2427	2385	2344	2302	56
57	2778	2732	2687	2643	2599	2555	2512	2469	2426	2384	2343	2302	57
58	2777	2731	2686	2642	2598	2554	2511	2468	2426	2384	2342	2301	58
59	2776	2731	2686	2641	2597	2553	2510	2469	2425	2383	2341	2300	59
60	2775	2730	2685	2640	2596	2553	2510	2467	2424	2382	2341	2300	60

TABLE 74

PROPORTIONAL LOGARITHMS

sec. ″	h m 1° 46′	h m 1° 47′	h m 1° 48′	h m 1° 49′	h m 1° 50′	h m 1° 51′	h m 1° 52′	h m 1° 53′	h m 1° 54′	h m 1° 55′	h m 1° 56′	h m 1° 57′	sec. ″
0	2300	2259	2218	2178	2139	2099	2061	2022	1984	1946	1908	1871	0
1	2299	2258	2218	2178	2138	2099	2060	2021	1983	1945	1907	1870	1
2	2298	2257	2217	2177	2137	2098	2059	2021	1982	1944	1907	1870	2
3	2298	2257	2216	2176	2137	2098	2059	2020	1982	1944	1906	1869	3
4	2297	2256	2216	2176	2136	2097	2058	2019	1981	1943	1906	1868	4
5	2296	2255	2215	2175	2135	2096	2057	2019	1980	1943	1905	1868	5
6	2296	2255	2214	2174	2135	2096	2057	2018	1980	1942	1904	1867	6
7	2295	2254	2214	2174	2134	2095	2056	2017	1979	1941	1904	1867	7
8	2294	2253	2213	2173	2133	2094	2055	2017	1979	1941	1903	1866	8
9	2294	2253	2212	2172	2133	2094	2055	2016	1978	1940	1903	1865	9
10	2293	2252	2212	2172	2132	2093	2054	2016	1977	1939	1902	1865	10
11	2292	2251	2211	2171	2132	2092	2053	2015	1977	1939	1901	1864	11
12	2291	2251	2210	2170	2131	2092	2053	2014	1976	1938	1901	1863	12
13	2291	2250	2210	2170	2130	2091	2052	2014	1975	1938	1900	1863	13
14	2290	2249	2209	2169	2130	2090	2051	2013	1975	1937	1899	1862	14
15	2289	2249	2208	2169	2129	2090	2051	2012	1974	1936	1899	1862	15
16	2289	2248	2208	2168	2128	2089	2050	2012	1973	1936	1898	1861	16
17	2288	2247	2207	2167	2128	2088	2050	2011	1973	1935	1898	1860	17
18	2287	2247	2206	2167	2127	2088	2049	2010	1972	1934	1897	1860	18
19	2287	2246	2206	2166	2126	2087	2048	2010	1972	1934	1896	1859	19
20	2286	2245	2205	2165	2126	2086	2048	2009	1971	1933	1896	1858	20
21	2285	2245	2204	2165	2125	2086	2047	2009	1970	1933	1895	1858	21
22	2285	2244	2204	2164	2124	2085	2046	2008	1970	1932	1894	1857	22
23	2284	2243	2203	2163	2124	2084	2046	2007	1969	1931	1894	1857	23
24	2283	2243	2202	2163	2123	2084	2045	2007	1968	1931	1893	1856	24
25	2283	2242	2202	2162	2122	2083	2044	2006	1968	1930	1893	1855	25
26	2282	2241	2201	2161	2122	2083	2044	2005	1967	1929	1892	1855	26
27	2281	2241	2200	2161	2121	2082	2043	2005	1967	1929	1891	1854	27
28	2281	2240	2200	2160	2120	2081	2042	2004	1966	1928	1891	1854	28
29	2280	2239	2199	2159	2120	2081	2042	2003	1965	1927	1890	1853	29
30	2279	2239	2198	2159	2119	2080	2041	2003	1965	1927	1889	1852	30
31	2279	2238	2198	2158	2118	2079	2041	2002	1964	1926	1889	1852	31
32	2278	2237	2197	2157	2118	2079	2040	2001	1963	1926	1888	1851	32
33	2277	2237	2196	2157	2117	2078	2039	2001	1963	1925	1888	1850	33
34	2276	2236	2196	2156	2116	2077	2039	2000	1962	1924	1887	1850	34
35	2276	2235	2195	2155	2116	2077	2038	2000	1961	1924	1886	1849	35
36	2275	2235	2194	2155	2115	2076	2037	1999	1961	1923	1886	1849	36
37	2274	2234	2194	2154	2114	2075	2037	1998	1960	1922	1885	1848	37
38	2274	2233	2193	2153	2114	2075	2036	1998	1960	1922	1884	1847	38
39	2273	2233	2192	2153	2113	2074	2035	1997	1959	1921	1884	1847	39
40	2272	2232	2192	2152	2113	2073	2035	1996	1958	1921	1883	1846	40
41	2272	2231	2191	2151	2112	2073	2034	1996	1958	1920	1883	1846	41
42	2271	2231	2190	2151	2111	2072	2033	1995	1957	1919	1882	1845	42
43	2270	2230	2190	2150	2111	2071	2033	1994	1956	1919	1881	1844	43
44	2270	2229	2189	2149	2110	2071	2032	1994	1956	1918	1881	1844	44
45	2269	2229	2188	2149	2109	2070	2032	1993	1955	1918	1880	1843	45
46	2268	2228	2188	2148	2109	2070	2031	1993	1955	1917	1879	1842	46
47	2268	2227	2187	2147	2108	2069	2030	1992	1954	1916	1879	1842	47
48	2267	2227	2186	2147	2107	2068	2030	1991	1953	1916	1878	1841	48
49	2266	2226	2186	2146	2107	2068	2029	1991	1953	1915	1878	1841	49
50	2266	2225	2185	2145	2106	2067	2028	1990	1952	1914	1877	1840	50
51	2265	2225	2184	2145	2105	2066	2028	1989	1951	1914	1876	1839	51
52	2264	2224	2184	2144	2105	2066	2027	1989	1951	1913	1876	1839	52
53	2264	2223	2183	2143	2104	2065	2026	1988	1950	1912	1875	1838	53
54	2263	2223	2182	2143	2103	2064	2026	1987	1950	1912	1875	1838	54
55	2262	2222	2182	2142	2103	2064	2025	1987	1949	1911	1874	1837	55
56	2262	2221	2181	2141	2102	2063	2024	1986	1948	1911	1873	1836	56
57	2261	2220	2180	2141	2101	2062	2024	1986	1948	1910	1873	1836	57
58	2260	2220	2180	2140	2101	2062	2023	1985	1947	1909	1872	1835	58
59	2260	2219	2179	2139	2100	2061	2023	1984	1946	1909	1871	1834	59
60	2259	2218	2178	2139	2099	2061	2022	1984	1946	1908	1871	1834	60

PROPORTIONAL LOGARITHMS

sec. ″	1h 58m	1h 59m	2h 0m	2h 1m	2h 2m	2h 3m	2h 4m	2h 5m	2h 6m	2h 7m	2h 8m	2h 9m	2h 10m	sec. ″
0	1834	1797	1761	1725	1689	1654	1619	1584	1549	1515	1481	1447	1413	0
1	1833	1797	1760	1724	1688	1653	1618	1583	1548	1514	1480	1446	1413	1
2	1833	1796	1760	1724	1688	1652	1617	1582	1548	1514	1479	1446	1412	2
3	1832	1795	1759	1723	1687	1652	1617	1582	1547	1513	1479	1445	1412	3
4	1831	1795	1758	1722	1687	1651	1616	1581	1547	1512	1478	1445	1411	4
5	1831	1794	1758	1722	1686	1651	1616	1581	1546	1512	1478	1444	1410	5
6	1830	1794	1757	1721	1686	1650	1615	1580	1546	1511	1477	1443	1410	6
7	1830	1793	1757	1721	1685	1650	1614	1580	1545	1511	1477	1443	1409	7
8	1829	1792	1756	1720	1684	1649	1614	1579	1544	1510	1476	1442	1409	8
9	1828	1792	1755	1719	1684	1648	1613	1578	1544	1510	1476	1442	1408	9
10	1828	1791	1755	1719	1683	1648	1613	1578	1543	1509	1475	1441	1408	10
11	1827	1791	1754	1718	1683	1647	1612	1577	1543	1508	1474	1441	1407	11
12	1827	1790	1754	1718	1682	1647	1612	1577	1542	1508	1474	1440	1407	12
13	1826	1789	1753	1717	1681	1646	1611	1576	1542	1507	1473	1440	1406	13
14	1825	1789	1752	1716	1681	1645	1610	1575	1541	1507	1473	1439	1405	14
15	1825	1788	1752	1716	1680	1645	1610	1575	1540	1506	1472	1438	1405	15
16	1824	1787	1751	1715	1680	1644	1609	1574	1540	1506	1472	1438	1404	16
17	1823	1787	1751	1715	1679	1644	1609	1574	1539	1505	1471	1437	1404	17
18	1823	1786	1750	1714	1678	1643	1608	1573	1539	1504	1470	1437	1403	18
19	1822	1786	1749	1713	1678	1642	1607	1573	1538	1504	1470	1436	1403	19
20	1822	1785	1749	1713	1677	1642	1607	1572	1538	1503	1469	1436	1402	20
21	1821	1785	1748	1712	1677	1641	1606	1571	1537	1503	1469	1435	1402	21
22	1820	1784	1748	1712	1676	1641	1606	1571	1536	1502	1468	1434	1401	22
23	1820	1783	1747	1711	1675	1640	1605	1570	1536	1502	1468	1434	1400	23
24	1819	1783	1746	1711	1675	1640	1605	1570	1535	1501	1467	1433	1400	24
25	1819	1782	1746	1710	1674	1639	1604	1569	1535	1500	1466	1433	1399	25
26	1818	1781	1745	1709	1674	1638	1603	1569	1534	1500	1466	1432	1399	26
27	1817	1781	1745	1709	1673	1638	1603	1568	1534	1499	1465	1432	1398	27
28	1817	1780	1744	1708	1673	1637	1602	1567	1533	1499	1465	1431	1398	28
29	1816	1780	1743	1708	1672	1637	1602	1567	1532	1498	1464	1431	1397	29
30	1816	1779	1743	1707	1671	1636	1601	1566	1532	1498	1464	1430	1397	30
31	1815	1778	1742	1706	1671	1635	1600	1566	1531	1497	1463	1429	1396	31
32	1814	1778	1742	1706	1670	1635	1600	1565	1531	1496	1463	1429	1395	32
33	1814	1777	1741	1705	1670	1634	1599	1565	1530	1496	1462	1428	1395	33
34	1813	1777	1740	1705	1669	1634	1599	1564	1529	1495	1461	1428	1394	34
35	1812	1776	1740	1704	1668	1633	1598	1563	1529	1495	1461	1427	1394	35
36	1812	1775	1739	1703	1668	1633	1598	1563	1528	1494	1460	1427	1393	36
37	1811	1775	1739	1703	1667	1632	1597	1562	1528	1494	1460	1426	1393	37
38	1811	1774	1738	1702	1667	1631	1596	1562	1527	1493	1459	1426	1392	38
39	1810	1774	1737	1702	1666	1631	1596	1561	1527	1493	1459	1425	1392	39
40	1809	1773	1737	1701	1665	1630	1595	1560	1526	1492	1458	1424	1391	40
41	1809	1772	1736	1700	1665	1630	1595	1560	1525	1491	1457	1424	1390	41
42	1808	1772	1736	1700	1664	1629	1594	1559	1525	1491	1457	1423	1390	42
43	1808	1771	1735	1699	1664	1628	1593	1559	1524	1490	1456	1423	1389	43
44	1807	1771	1734	1699	1663	1628	1593	1558	1524	1490	1456	1422	1389	44
45	1806	1770	1734	1698	1663	1627	1592	1558	1523	1489	1455	1422	1388	45
46	1806	1769	1733	1697	1662	1627	1592	1557	1523	1489	1455	1421	1388	46
47	1805	1769	1733	1697	1661	1626	1591	1556	1522	1488	1454	1420	1387	47
48	1805	1768	1732	1696	1661	1626	1591	1556	1522	1487	1454	1420	1387	48
49	1804	1768	1731	1696	1660	1625	1590	1555	1521	1487	1453	1419	1386	49
50	1803	1767	1731	1695	1660	1624	1589	1555	1520	1486	1452	1419	1386	50
51	1803	1766	1730	1694	1659	1624	1589	1554	1520	1486	1452	1418	1385	51
52	1802	1766	1730	1694	1658	1623	1588	1554	1519	1485	1451	1418	1384	52
53	1801	1765	1729	1693	1658	1623	1588	1553	1518	1485	1451	1417	1384	53
54	1801	1765	1728	1693	1657	1622	1587	1552	1518	1484	1450	1417	1383	54
55	1800	1764	1728	1692	1657	1621	1586	1552	1518	1483	1450	1416	1383	55
56	1800	1763	1727	1691	1656	1621	1586	1551	1517	1483	1449	1415	1382	56
57	1799	1763	1727	1691	1655	1620	1585	1551	1516	1482	1449	1415	1382	57
58	1798	1762	1726	1690	1655	1620	1585	1550	1516	1482	1448	1414	1381	58
59	1798	1761	1725	1690	1654	1619	1584	1550	1515	1481	1447	1414	1381	59
60	1797	1761	1725	1689	1654	1619	1584	1549	1515	1481	1447	1413	1380	60

PROPORTIONAL LOGARITHMS

sec. ″	h m 2° 11′	h m 2° 12′	h m 2° 13′	h m 2° 14′	h m 2° 15′	h m 2° 16′	h m 2° 17′	h m 2° 18′	h m 2° 19′	h m 2° 20′	h m 2° 21′	h m 2° 22′	sec. ″
0	1380	1347	1314	1282	1249	1217	1186	1154	1123	1091	1061	1030	0
1	1379	1346	1314	1281	1249	1217	1185	1153	1122	1091	1060	1029	1
2	1379	1346	1313	1281	1248	1216	1184	1153	1121	1090	1059	1029	2
3	1378	1345	1313	1280	1248	1216	1184	1152	1121	1090	1059	1028	3
4	1378	1345	1312	1279	1247	1215	1183	1152	1120	1089	1058	1028	4
5	1377	1344	1311	1279	1247	1215	1183	1151	1120	1089	1058	1027	5
6	1377	1344	1311	1278	1246	1214	1182	1151	1119	1088	1057	1027	6
7	1376	1343	1310	1278	1246	1214	1182	1150	1119	1088	1057	1026	7
8	1376	1343	1310	1277	1245	1213	1181	1150	1118	1087	1056	1026	8
9	1375	1342	1309	1277	1245	1213	1181	1149	1118	1087	1056	1025	9
10	1374	1341	1309	1276	1244	1212	1180	1149	1117	1086	1055	1025	10
11	1374	1341	1308	1276	1243	1211	1180	1148	1117	1086	1055	1024	11
12	1373	1340	1308	1275	1243	1211	1179	1148	1116	1085	1054	1024	12
13	1373	1340	1307	1275	1242	1210	1179	1147	1116	1085	1054	1023	13
14	1372	1339	1307	1274	1242	1210	1178	1147	1115	1084	1053	1023	14
15	1372	1339	1306	1274	1241	1209	1178	1146	1115	1084	1053	1022	15
16	1371	1338	1305	1273	1241	1209	1177	1146	1114	1083	1052	1022	16
17	1371	1338	1305	1272	1240	1208	1177	1145	1114	1083	1052	1021	17
18	1370	1337	1304	1272	1240	1208	1176	1145	1113	1082	1051	1021	18
19	1369	1337	1304	127[illegible]	1239	1207	1175	1144	1113	1082	1051	1020	19
20	1369	1336	1303	1271	1239	1207	1175	1143	1112	1081	1050	1020	20
21	1368	1335	1303	1270	1238	1206	1174	1143	1112	1081	1050	1019	21
22	1368	1335	1302	1270	1238	1206	1174	1142	1111	1080	1049	1019	22
23	1367	1334	1302	1269	1237	1205	1173	1142	1111	1080	1049	1018	23
24	1367	1334	1301	1269	1237	1205	1173	1141	1110	1079	1048	1018	24
25	1366	1333	1301	1268	1236	1204	1172	1141	1110	1079	1048	1017	25
26	1366	1333	1300	1268	1235	1203	1172	1140	1109	1078	1047	1017	26
27	1365	1332	1300	1267	1235	1203	1171	1140	1109	1078	1047	1016	27
28	1365	1332	1299	1267	1234	1202	1171	1139	1108	1077	1046	1016	28
29	1364	1331	1298	1266	1234	1202	1170	1139	1107	1076	1046	1015	29
30	1363	1331	1298	1266	1233	1201	1170	1138	1107	1076	1045	1015	30
31	1363	1330	1297	1265	1233	1201	1169	1138	1106	1075	1045	1014	31
32	1362	1329	1297	1264	1232	1200	1169	1137	1106	1075	1044	1014	32
33	1362	1329	1296	1264	1232	1200	1168	1137	1105	1074	1044	1013	33
34	1361	1328	1296	1263	1231	1199	1168	1136	1105	1074	1043	1013	34
35	1361	1328	1295	1263	1231	1199	1167	1136	1104	1073	1043	1012	35
36	1360	1327	1295	1262	1230	1198	1167	1135	1104	1073	1042	1012	36
37	1360	1327	1294	1262	1230	1198	1166	1135	1103	1072	1042	1011	37
38	1359	1326	1294	1261	1229	1197	1165	1134	1103	1072	1041	1010	38
39	1359	1326	1293	1261	1229	1197	1165	1134	1102	1071	1041	1010	39
40	1358	1325	1292	1260	1228	1196	1164	1133	1102	1071	1040	1009	40
41	1357	1325	1292	1260	1227	1196	1164	1132	1101	1070	1039	1009	41
42	1357	1324	1291	1259	1227	1195	1163	1132	1101	1070	1039	1008	42
43	1356	1323	1291	1258	1226	1194	1163	1131	1100	1069	1038	1008	43
44	1356	1323	1290	1258	1226	1194	1162	1131	1100	1069	1038	1007	44
45	1355	1322	1290	1257	1225	1193	1162	1130	1099	1068	1037	1007	45
46	1355	1322	1289	1257	1225	1193	1161	1130	1099	1068	1037	1006	46
47	1354	1321	1289	1256	1224	1192	1161	1129	1098	1067	1036	1006	47
48	1354	1321	1288	1256	1224	1192	1160	1129	1098	1067	1036	1005	48
49	1353	1320	1288	1255	1223	1191	1160	1128	1097	1066	1035	1005	49
50	1352	1320	1287	1255	1223	1191	1159	1128	1097	1066	1035	1004	50
51	1352	1319	1287	1254	1222	1190	1159	1127	1096	1065	1034	1004	51
52	1351	1319	1286	1254	1222	1190	1158	1127	1096	1065	1034	1003	52
53	1351	1318	1285	1253	1221	1189	1158	1126	1095	1064	1033	1003	53
54	1350	1317	1285	1253	1221	1189	1157	1126	1095	1064	1033	1002	54
55	1350	1317	1284	1252	1220	1188	1157	1125	1094	1063	1032	1002	55
56	1349	1316	1284	1251	1219	1188	1156	1125	1093	1063	1032	1001	56
57	1349	1316	1283	1251	1219	1187	1156	1124	1093	1062	1031	1001	57
58	1348	1315	1283	1250	1218	1187	1155	1124	1092	1062	1031	1000	58
59	1347	1315	1282	1250	1218	1186	1154	1123	1092	1061	1030	1000	59
60	1347	1314	1282	1249	1217	1186	1154	1123	1091	1061	1030	0999	60

PROPORTIONAL LOGARITHMS

sec. ″	h m 2° 23′	h m 2° 24′	h m 2° 25′	h m 2° 26′	h m 2° 27′	h m 2° 28′	h m 2° 29′	h m 2° 30′	h m 2° 31′	h m 2° 32′	h m 2° 33′	h m 2° 34′	sec. ″
0	0999	0969	0939	0909	0880	0850	0821	0792	0763	0734	0706	0678	0
1	0999	0969	0939	0909	0879	0850	0820	0791	0762	0734	0705	0677	1
2	0998	0968	0938	0908	0879	0849	0820	0791	0762	0733	0705	0677	2
3	0998	0968	0938	0908	0878	0849	0819	0790	0762	0733	0704	0676	3
4	0997	0967	0937	0907	0878	0848	0819	0790	0761	0732	0704	0676	4
5	0997	0967	0937	0907	0877	0848	0818	0789	0761	0732	0703	0675	5
6	0996	0966	0936	0906	0877	0847	0818	0789	0760	0731	0703	0675	6
7	0996	0966	0936	0906	0876	0847	0817	0788	0760	0731	0702	0674	7
8	0995	0965	0935	0905	0876	0846	0817	0788	0759	0730	0702	0674	8
9	0995	0965	0935	0905	0875	0846	0816	0787	0759	0730	0702	0673	9
10	0994	0964	0934	0904	0875	0845	0816	0787	0758	0729	0701	0673	10
11	0994	0964	0934	0904	0874	0845	0815	0787	0758	0729	0701	0672	11
12	0993	0963	0933	0903	0874	0844	0815	0786	0757	0729	0700	0672	12
13	0993	0963	0933	0903	0873	0844	0815	0786	0757	0728	0700	0671	13
14	0992	0962	0932	0902	0873	0843	0814	0785	0756	0728	0699	0671	14
15	0992	0962	0932	0902	0872	0843	0814	0785	0756	0727	0699	0670	15
16	0991	0961	0931	0901	0872	0842	0813	0784	0755	0727	0698	0670	16
17	0991	0961	0931	0901	0871	0842	0813	0784	0755	0726	0698	0669	17
18	0990	0960	0930	0900	0871	0841	0812	0783	0754	0726	0697	0669	18
19	0990	0960	0930	0900	0870	0841	0812	0783	0754	0725	0697	0669	19
20	0989	0959	0929	0899	0870	0840	0811	0782	0753	0725	0696	0668	20
21	0989	0959	0929	0899	0869	0840	0811	0782	0753	0724	0696	0668	21
22	0988	0958	0928	0898	0869	0839	0810	0781	0752	0724	0695	0667	22
23	0988	0958	0928	0898	0868	0839	0810	0781	0752	0723	0695	0667	23
24	0987	0957	0927	0897	0868	0838	0809	0780	0751	0723	0694	0666	24
25	0987	0957	0927	0897	0867	0838	0809	0780	0751	0722	0694	0666	25
26	0986	0956	0926	0896	0867	0837	0808	0779	0750	0722	0693	0665	26
27	0986	0956	0926	0896	0866	0837	0808	0779	0750	0721	0693	0665	27
28	0985	0955	0925	0895	0866	0836	0807	0778	0750	0721	0693	0664	28
29	0985	0955	0925	0895	0865	0836	0807	0778	0749	0720	0692	0664	29
30	0984	0954	0924	0894	0865	0835	0806	0777	0749	0720	0692	0663	30
31	0984	0954	0924	0894	0864	0835	0806	0777	0748	0720	0691	0663	31
32	0983	0953	0923	0893	0864	0834	0805	0776	0748	0719	0691	0662	32
33	0983	0953	0923	0893	0863	0834	0805	0776	0747	0719	0690	0662	33
34	0982	0952	0922	0892	0863	0833	0804	0775	0747	0718	0690	0662	34
35	0982	0952	0922	0892	0862	0833	0804	0775	0746	0718	0689	0661	35
36	0981	0951	0921	0891	0862	0833	0803	0774	0746	0717	0689	0661	36
37	0981	0951	0921	0891	0861	0832	0803	0774	0745	0717	0688	0660	37
38	0980	0950	0920	0890	0861	0832	0802	0773	0745	0716	0688	0660	38
39	0980	0950	0920	0890	0860	0831	0802	0773	0744	0716	0687	0659	39
40	0979	0949	0919	0889	0860	0831	0801	0773	0744	0715	0687	0659	40
41	0979	0949	0919	0889	0859	0830	0801	0772	0743	0715	0686	0658	41
42	0978	0948	0918	0888	0859	0830	0801	0772	0743	0714	0686	0658	42
43	0978	0948	0918	0888	0858	0829	0800	0771	0742	0714	0685	0657	43
44	0977	0947	0917	0887	0858	0829	0800	0771	0742	0713	0685	0657	44
45	0977	0947	0917	0887	0857	0828	0799	0770	0741	0713	0685	0656	45
46	0976	0946	0916	0886	0857	0828	0799	0770	0741	0712	0684	0656	46
47	0976	0946	0916	0886	0856	0827	0798	0769	0740	0712	0684	0655	47
48	0975	0945	0915	0885	0856	0827	0798	0769	0740	0711	0683	0655	48
49	0975	0945	0915	0885	0855	0826	0797	0768	0739	0711	0683	0655	49
50	0974	0944	0914	0884	0855	0826	0797	0768	0739	0711	0682	0654	50
51	0974	0944	0914	0884	0855	0825	0796	0767	0739	0710	0682	0654	51
52	0973	0943	0913	0883	0854	0825	0796	0767	0738	0710	0681	0653	52
53	0973	0943	0913	0883	0854	0824	0795	0766	0738	0709	0681	0653	53
54	0972	0942	0912	0882	0853	0824	0795	0766	0737	0709	0680	0652	54
55	0972	0942	0912	0882	0853	0823	0794	0765	0737	0708	0680	0652	55
56	0971	0941	0911	0881	0852	0823	0794	0765	0736	0708	0679	0651	56
57	0971	0941	0911	0881	0852	0822	0793	0764	0736	0707	0679	0651	57
58	0970	0940	0910	0880	0851	0822	0793	0764	0735	0707	0678	0650	58
59	0970	0940	0910	0880	0851	0821	0792	0763	0735	0706	0678	0650	59
60	0969	0939	0909	0880	0850	0821	0792	0763	0734	0706	0678	0649	60

PROPORTIONAL LOGARITHMS

sec. ″	h m 2° 35′	h m 2° 36′	h m 2° 37′	h m 2° 38′	h m 2° 39′	h m 2° 40′	h m 2° 41′	h m 2° 42′	h m 2° 43′	h m 2° 44′	h m 2° 45′	h m 2° 46′	sec ″
0	0649	0621	0594	0566	0539	0512	0484	0458	0431	0404	0378	0352	0
1	0649	0621	0593	0566	0538	0511	0484	0457	0430	0404	0377	0351	1
2	0648	0621	0593	0565	0538	0511	0484	0457	0430	0403	0377	0351	2
3	0648	0620	0592	0565	0537	0510	0483	0456	0430	0403	0377	0350	3
4	0648	0620	0592	0564	0537	0510	0483	0456	0429	0402	0376	0350	4
5	0647	0619	0591	0564	0536	0509	0482	0455	0429	0402	0376	0349	5
6	0647	0619	0591	0563	0536	0509	0482	0455	0428	0402	0375	0349	6
7	0646	0618	0590	0563	0536	0508	0481	0454	0428	0401	0375	0349	7
8	0646	0618	0590	0562	0535	0508	0481	0454	0427	0401	0374	0348	8
9	0645	0617	0590	0562	0535	0507	0480	0454	0427	0400	0374	0348	9
10	0645	0617	0589	0562	0534	0507	0480	0453	0426	0400	0373	0347	10
11	0644	0616	0589	0561	0534	0507	0479	0453	0426	0399	0373	0347	11
12	0644	0616	0588	0561	0533	0506	0479	0452	0426	0399	0373	0346	12
13	0643	0615	0588	0560	0533	0506	0479	0452	0425	0399	0372	0346	13
14	0643	0615	0587	0560	0532	0505	0478	0451	0425	0398	0372	0346	14
15	0642	0615	0587	0559	0532	0505	0478	0451	0424	0398	0371	0345	15
16	0642	0614	0586	0559	0531	0504	0477	0450	0424	0397	0371	0345	16
17	0641	0614	0586	0558	0531	0504	0477	0450	0423	0397	0370	0344	17
18	0641	0613	0585	0558	0531	0503	0476	0450	0423	0396	0370	0344	18
19	0641	0613	0585	0557	0530	0503	0476	0449	0422	0396	0370	0343	19
20	0640	0612	0584	0557	0530	0502	0475	0449	0422	0395	0369	0343	20
21	0640	0612	0584	0557	0529	0502	0475	0448	0422	0395	0369	0342	21
22	0639	0611	0584	0556	0529	0502	0475	0448	0421	0395	0368	0342	22
23	0639	0611	0583	0556	0528	0501	0474	0447	0421	0394	0368	0342	23
24	0638	0610	0583	0555	0528	0501	0474	0447	0420	0394	0367	0341	24
25	0638	0610	0582	0555	0527	0500	0473	0446	0420	0393	0367	0341	25
26	0637	0609	0582	0554	0527	0500	0473	0446	0419	0393	0366	0340	26
27	0637	0609	0581	0554	0526	0499	0472	0446	0419	0392	0366	0340	27
28	0636	0608	0581	0553	0526	0499	0472	0445	0418	0392	0366	0339	28
29	0636	0608	0580	0553	0526	0498	0471	0445	0418	0391	0365	0339	29
30	0635	0608	0580	0552	0525	0498	0471	0444	0418	0391	0365	0339	30
31	0635	0607	0579	0552	0525	0497	0471	0444	0417	0391	0364	0338	31
32	0634	0607	0579	0551	0524	0497	0470	0443	0417	0390	0364	0338	32
33	0634	0606	0579	0551	0524	0497	0470	0443	0416	0390	0363	0337	33
34	0634	0606	0578	0551	0523	0496	0469	0442	0416	0389	0363	0337	34
35	0633	0605	0578	0550	0523	0496	0469	0442	0415	0389	0363	0336	35
36	0633	0605	0577	0550	0522	0495	0468	0442	0415	0388	0362	0336	36
37	0632	0604	0577	0549	0522	0495	0468	0441	0414	0388	0362	0336	37
38	0632	0604	0576	0549	0521	0494	0467	0441	0414	0388	0361	0335	38
39	0631	0603	0576	0548	0521	0494	0467	0440	0414	0387	0361	0335	39
40	0631	0603	0575	0548	0521	0493	0466	0440	0413	0387	0360	0334	40
41	0630	0602	0575	0547	0520	0493	0466	0439	0413	0386	0360	0334	41
42	0630	0602	0574	0547	0520	0493	0466	0439	0412	0386	0359	0333	42
43	0629	0602	0574	0546	0519	0492	0465	0438	0412	0385	0359	0333	43
44	0629	0601	0573	0546	0519	0492	0465	0438	0411	0385	0359	0332	44
45	0628	0601	0573	0546	0518	0491	0464	0438	0411	0384	0358	0332	45
46	0628	0600	0573	0545	0518	0491	0464	0437	0410	0384	0358	0332	46
47	0627	0600	0572	0545	0517	0490	0463	0437	0410	0384	0357	0331	47
48	0627	0599	0572	0544	0517	0490	0463	0436	0410	0383	0357	0331	48
49	0627	0599	0571	0544	0516	0489	0462	0436	0409	0383	0356	0330	49
50	0626	0598	0571	0543	0516	0489	0462	0435	0409	0382	0356	0330	50
51	0626	0598	0570	0543	0516	0489	0462	0435	0408	0382	0356	0329	51
52	0625	0597	0570	0542	0515	0488	0461	0434	0408	0381	0355	0329	52
53	0625	0597	0569	0542	0515	0488	0461	0434	0407	0381	0355	0329	53
54	0624	0596	0569	0541	0514	0487	0460	0434	0407	0381	0354	0328	54
55	0624	0596	0568	0541	0514	0487	0460	0433	0406	0380	0354	0328	55
56	0623	0596	0568	0541	0513	0486	0459	0433	0406	0380	0353	0327	56
57	0623	0595	0568	0540	0513	0486	0459	0432	0406	0379	0353	0327	57
58	0622	0595	0567	0540	0512	0485	0458	0432	0405	0379	0352	0326	58
59	0622	0594	0567	0539	0512	0485	0458	0431	0405	0378	0352	0326	59
60	0621	0594	0566	0539	0512	0484	0458	0431	0404	0378	0352	0326	60

PROPORTIONAL LOGARITHMS

sec. ″	h m 2° 47′	h m 2° 48′	h m 2° 49′	h m 2° 50′	h m 2° 51′	h m 2° 52′	h m 2° 53′	h m 2° 54′	h m 2° 55′	h m 2° 56′	h m 2° 57′	h m 2° 58′	h m 2° 59′	sec. ″
0	0326	0300	0274	0248	0223	0197	0172	0147	0122	0098	0073	0049	0024	0
1	0325	0299	0273	0248	0222	0197	0172	0147	0122	0097	0073	0048	0024	1
2	0325	0299	0273	0247	0222	0197	0171	0146	0121	0097	0072	0048	0023	2
3	0324	0298	0273	0247	0221	0196	0171	0146	0121	0096	0072	0047	0023	3
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ABBREVIATIONS ADOPTED IN THE ADMIRALTY CHARTS, WITH EXPLANATORY NOTES.

General Abbreviations.

Anch^{ge} - *Anchorage.*
B. - *Bay.*
B. (near a buoy) *Black.*
Bat^{y} - *Battery.*
B^{k} - *Bank.*
C. - *Cape.*
C.G. - *Coast Guard.*
Cath. - *Cathedral.*
Ch. - *Church.*
Chan. - *Channel.*
Cheq. (near a buoy.) *Chequered.*
Col^{d} - *Coloured.*
Cr. - *Creek.*
E.D. - *Existence Doubtful.*
Fl^{g} L^{t} - *Floating Light.*
Fms. - *Fathoms.*
Ft. - *Feet or Foot.*
G. - *Gulf.*
G^{t} - *Great.*
H. - *Hour.*
H^{d} - *Head.*
Ho. - *House.*
H^{r} - *Harbour.*
H.S. (near a buoy) *Horizontal Stripes.*

H.W. - *High Water.*
H.W.F.&C. - *High Water, Full & Change.*
I. - *Island.*
I^{s} - *Islands.*
Kn. - *Knots.*
L. - *Lake.*
Lat. - *Latitude.*
Long. - *Longitude.*
L^{t} - *Light.*
L^{t} Alt. - „ *Alternating.*
L^{t} F.Fl. - „ *Fixed and Flashing.*
L^{t} F. - „ *Fixed.*
L^{t} Fl. - „ *Flashing.*
L^{t} Int. - „ *Intermittent.*
L^{t} Occ. - „ *Occulting.*
L^{t} Rev. - „ *Revolving.*
L.W. - *Low Water.*
m. (near a light) *Nautical Mile.*
Mag^{z} - *Magazine.*
Mag^{c} - *Magnetic.*
m n (near a light) *Minutes.*
Mt. - *Mountain.*
Np. - *Neaps.*

Obs^{n} Spot *Observation Spot* +
P. - *Port.*
P D. - *Position doubtful.*
P^{k} - *Peak.*
P^{t} - *Point.*
R - *River.*
R. (near a buoy) *Red.*
R^{f} - *Reef.*
R^{k} - *Rock*
S^{d} - *Sound.*
sec. (near a light) *Seconds.*
Sh. - *Shoal.*
Sp - *Springs*
Str. - *Strait.*
Tel. - *Telegraph.*
Var^{n} - *Variation.*
Vil. - *Village*
vis (near a light) *Visible.*
V S. (near a buoy) *Vertical Stripes*
W. (near a buoy) *White.*
W^{g}. Pl. - *Watering Place.*

Quality of the Bottom.

b. - *blue.*
blk. - *black.*
br. - *brown.*
brk. - *broken.*
c. - *coarse.*
cl - *clay.*
crl. - *coral.*
d. - *dark.*
f. - *fine.*
g. - *gravel.*
gl. - *globigerina.*

gn. - *green.*
grd. - *ground.*
gy. - *gray.*
h. - *hard.*
m. - *mud.*
oys. - *oysters.*
oz. - *ooze.*
pch. - *pebbles.*
pt. - *pteropod.*
r. - *rock.*

rot - *rotten.*
s. - *sand.*
sft. - *soft.*
sh. - *shells.*
spk. - *speckled.*
st. - *stones.*
stf. - *stiff.*
w. - *white.*
wd. - *weed.*
y. - *yellow.*

All charts and plans are, where practicable, constructed upon the True Meridian, *i.e.*, the East and the West marginal lines are drawn parallel to the True Meridian

Soundings are reduced to mean Low Water of ordinary Spring tides, and are expressed in fathoms (of 6 feet) and fractions of a fathom, or in feet and fractions of a foot, such being denoted in the title of the Chart.

The underlined figures on the dry banks represent in feet or fathoms the depth of water over them at High Water, or the heights of the banks above Low Water. The method adopted is explained in the Title of the Chart. This dual system is being abolished, and in future all underlined figures will indicate feet above Low Water.

The *Velocity* of Tide is expressed in knots and fractions of a knot. The *Period* of the Tide being shown thus: 1st Q^{r}. 2nd Q^{r}. 3rd Q^{r}. 4th Q^{r}. for 1st, 2nd, 3rd, and 4th quarters.

The *Rise* of Tide is measured from the mean Low Water level of Ordinary Springs. The *Range* of Tide is measured from the Low Water of one tide to the High Water of the following tide. *See* Diagram on p 344.

All heights are given in feet above High Water Ordinary Springs, and in places where there is no tide, above the level of the sea. [Exceptions to this general rule are stated on the title of the chart.]

All bearings, including the direction of winds and currents, are magnetic, except when otherwise expressed. Bearings of lights are given *as seen from seaward*, and not from the lights.

The natural scale, or the proportion which the Chart scale bears to the earth (obtained by reducing the number of feet in the minute of latitude to inches, and dividing the product by the scale), is represented thus $\frac{1}{12,100}$.

A cable's length is assumed to be equal to 100 fathoms; it is the 10th part of a sea mile.

Soundings upon Foreign Charts are expressed thus:—

Austrian	(Faden) = 6·223	English feet,	or	1·037	English	fathoms
Chilian	(Metre) = 3·281	,,	,,	0·547	,,	,,
Danish and Norwegian	(Favn) = 6·175	,,	,,	1·029	,,	,,
Dutch (European)	(Vadem) = 5·575	,,	,,	0·929	,,	,,
,, (East Indian)	,, = 5·905	,,	,,	0·984	,,	,,
French	(Brasse) = 5·329	,,	,,	0·888	,,	,,
,,	(Mètre) = 3·281	,,	,,	0·547	,,	,,
Italian	,, = 3·281	,,	,,	0·547	,,	,,
Japanese	(Fathom) = 6·000	,,	,,	1·000	,,	,,
Portuguese	(Braca) = 6·004	,,	,,	1·000	,,	,,
German	(Mètre) = 3·281	,,	,,	0·547	,,	,,
Russian, Sashine or Fathom	(Сажень) = 6·000	,,	,,	1·000	,,	,,
Spanish	(Braza) = 5·492	,,	,,	0·915	,,	,,
Swedish	(Famn) = 5·843	,,	,,	0·974	,,	,,
United States	(Fathom) = 6·000	,,	,,	1·000	,,	,,

The Dutch *Elle*, the Spanish, Portuguese, and Italian *Metro*, and also the French *Mètre*, are identical.

Characteristics marked against Lights on the Admiralty Charts.

F. Fixed. A continuous steady light.

Fl. Flashing. Showing a single flash.

Gp. Fl. Group flashing. Showing groups of two or more flashes in succession (not necessarily of the same colour), separated by eclipses.

F. & Fl. Fixed and flashing. Fixed light varied by a single white or coloured flash, which may be preceded and followed by a short eclipse.

F. & Gp. Fl. Fixed and group flashing. The same as the preceding, but with groups of flashes.

Rev. Revolving. Light gradually increasing to full effect, then decreasing to eclipse. [*At short distances and in clear weather a faint continuous light may be observed.*]

Occ. Occulting. A steady light with, at regular intervals, one sudden and total eclipse.

Gp. Occ. Group occulting. A steady light with, at regular intervals, groups of two or more sudden and total eclipses.

The note attached to Revolving lights is in some cases applicable.

Alt. Alternating. Lights of different colours (generally red and white) alternately, without any intervening eclipse.

The distance the Lights are visible is calculated from a height of 15 feet above the sea at H.W. Lt.-vessels belonging to the Trinity House, London, are coloured *red*, have their Name painted on their sides, carry a Ball at *each* mast-head, fire a gun if a ship is standing into danger, and sound either a Gong or Fog Horn in foggy weather. A *white* Lt. is exhibited from the fore-stay of each Lt.-vessel, 6 feet above the rail, to show in which direction the vessel is riding.

When Lt.-vessels or other craft are placed to mark the position of *wrecks*, they will be distinguished by having their *top-sides coloured green*, and will exhibit, by day *Three balls from a yard*, 20 feet above the sea; *two placed vertically on the side that shipping may safely pass*, and one on the other side. By night—*Three fixed white Lts. similarly arranged*, but the ordinary riding Lt. will not be shown. Mariners will thus know on sighting a wreck-marking vessel that she is so employed; and that *they should pass on that side of her on which the two balls or two Lts. are shown.*

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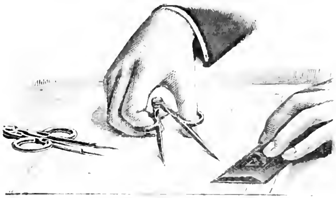

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